REVISE
.wales

3.15 — Right-angled trigonometry

Mark schemes for the 3.15 question pack

Spec 3.7.3, 3.7.4 — Unit 3

SOLUTIONS · 2025 SPECIFICATION

Mark schemes for the 29 questions in the corresponding revise.wales question pack (118 marks total). Sources: legacy WJEC GCSE papers, WJEC SAM, and custom-authored mark schemes. Pack layout © revise.wales.

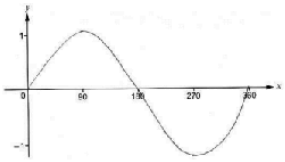
3(a) (diagonal^2 =) $3.3^2 + 3.3^2$ diagonal^2 = 21.78 or diagonal = $\sqrt{21.78}$ diagonal is 4.7 (cm)	 M1 A1 A1	*Scale drawings are not accepted in Q3* FT from M1 for the correctly evaluated square root of 'their 21.78' provided 'their answer' > 3.3 (cm) Must be to 1 d.p. Accept an unsupported 4.7(cm)
3(b) 11 × 4.6(669…) × 9.5 × 4.6(669…) or 11 × 4.7 × 9.5 × 4.7 or 104.5 × $(4.7)^2$ (Area =) 2276(.01cm^2)	M2 A1	FT for 'their derived diagonal', but not 3.3 cm M1 for sight of either 11 × 4.6(669…) or 9.5 × 4.6(669…) *(Height 44.3355… cm; width 51.3359…cm)* Accept answers in the range 2211 (cm^2) to 2308.41 (cm^2) from appropriate working *(Note: e.g. use of a diagonal such as 5.27(cm) allow appropriate calculation with 5.2 (cm) or 5.3 (cm) for M2, A1; however use of 5 throughout is a possible M2, A0)*

Autumn 2016		
8(a) Identifying the length 1·7 on a correct triangle	S1	May be seen or implied If (a) is unanswered, may be awarded from (b)
(Angle =) $\tan^{-1}(2{\cdot}1/1{\cdot}7)$	M2	If hypotenuse used, a complete method needed M1 for tan(angle) = 2·1/1·7
= 51(·009…)(°)	A1	Allow an answer that rounds to 51(°)
8(b) (Slant height of triangular face^2 =) $2{\cdot}1^2 + 1{\cdot}7^2$	M1	
Height^2 = 7·3	A1	
(Height =) 2·7(018…) OR $\sqrt{7{\cdot}3}$ (cm)	A1	FT from M1 for the correctly evaluated square root of 'their 7·3' provided 'their answer' > 2·1 (cm) *Alternative methods:* *M2 for (Height =) 2·1/sin 51(·009…)(°)* *OR M2 for (Height =) 1·7/cos 51(·009…)(°)* *FT 'their derived 51(·009…)(°)'* *M1 for sin 51(·009…)(°) = 2·1/Height* *OR M1 for cos 51(·009…)(°) = 1·7/Height* *A1 for 2·7(018…) (cm)*
(Total s. area =) $4\times\frac{1}{2}\times3{\cdot}4\times2{\cdot}7(018\ldots) + 3{\cdot}4^2$ OR $4\times\frac{1}{2}\times3{\cdot}4\times\sqrt{7{\cdot}3} + 3{\cdot}4^2$	M1	FT 'their derived 2·7(018…)' Note: $3{\cdot}4^2 = 11{\cdot}56$
= 29·9(325…)(cm^2)	A1	
(Cost of chocolate =) 2·39(46…) or 2·4 (p)	B1	FT 0·08×'their 29·9(325…)' provided at least one of the previous M1 marks awarded Allow an answer of 2 (p) from correct working If units are given, they must be correct

4. $\tan^{-1}$ 0.81(1…) or $\tan^{-1}$ 146/180 Angle of elevation is 39.(04…°)	M2 A1	M1 for tan (angle of elevation) = 146/180
Statement e.g. '(not safe as) too far (from the foot of the cliff)', 'too far out at sea'	E1	FT '**their acute angle**' provided at least M1 previously awarded, **with** • <42° being too far out, or • >45° too near the cliff, or • between these angles it is safe *Alternative for M marks, e.g.:* *sin (elevation) =* $\frac{146}{\sqrt{(180^2 + 146^2)}}$ *(* $= \frac{146}{231.767..}$*)* ***OR*** *cos (elevation) =* $\frac{180}{\sqrt{(180^2 + 146^2)}}$ *M1* $\sin^{-1}$ *0.62994.... OR* $\cos^{-1}$ *0.7766... M1* *If no marks:* *Award SC1 for an answer of 50.95…° or 51°* *AND 'too near'*

6.	$\frac{QR}{18} = \tan 24(°)$ $QR = 18 \times \tan 24(°)$ $= 8(\cdot 01..)(cm)$		M1 m1 A1	OR $\frac{QR}{\sin 24} = \frac{18}{\sin 66}$ $QR = \frac{18 \times \sin 24}{\sin 66}$ C.A.O.

Summer 2017			
15.(a) Correct sine curve with 1 and −1 shown on the y-axis and 180° and 360° shown on the x-axis.		B2	Multiple cycles gain both marks only if both axes fully correctly labelled for x between 0 and 360. If B2 not awarded, B1 for a sine curve (single cycle) with missing values on axes OR B1 for multiple cycles with (only) x axis correctly labelled.
15.(b) sin 340°		B1	

		calculating with replacement'.
14.(a) 	C1	Clear Intention to draw a curve. Curve must pass through (0,0), (180,0) and (360,0) AND intention to have maximum at (90,1) and minimum at (270,-1). Ignore curve shown for values $x < 0°$ or $x > 360°$.
14.(b)(i) 17 AND 163 OR 17.5 AND 162.5 OR 17.4(576…) AND 162.5(423…)	B2	If more than two answers offered award B1 for sight of one correct angle. Allow embedded answers. Rounded angles must add up to 180°. B1 for sight of one correct angle OR, B1 for two angles which total 180°. Allow different degrees of accuracy in rounding.
14.(b)(ii) 270(°)	B1	Allow an embedded answer.

5. $(QR^2 =)\ 1{\cdot}41^2 + 0{\cdot}89^2$ $(QR^2) = 2{\cdot}78(02)$ or $(QR) = \sqrt{2{\cdot}78(02)}$ $(QR =)\ 1{\cdot}66(\ldots)(m)$ or $1{\cdot}67$ (m) or $1{\cdot}7$(m) *OR 166·7(..) cm or 167cm*	M1 A1 A1	Allow 2·8 for 2·78. FT from M1 for the correctly evaluated square root of 'their 2.78(02)' provided their answer > 1.41 *Allow working in centimetres but penalise −1 from any A marks gained if units not shown for final answer* *e.g.* $QR^2 = 27802$ *(A1) , QR = 166·74 (A1) then −1* *BUT QR = 166·74 cm OR 167 cm is M1A1A1.*
Alternative method. ***Correct** use of 'two-step' trigonometric relationship.* *(QR =) 1·66(…)(m) or 1·67 (m) or 1·7(m)*	*M2* *A1*	*A partial trigonometric method is M0.* *C.A.O.*

		equations shown.
9.(a) Tan ACB = $\frac{6{\cdot}5}{10{\cdot}4}$ (ACB =) $\tan^{-1}$ 0·625 or $\tan^{-1}$ (6·5 / 10·4) (x) = 32(°)	M1 A1 A1	M1 for equivalent complete method. C.A.O. (Implies previous A1.) Accept an answer that rounds to 32(°)
Alternative method. ***Correct** use of 'two-step' method.* *(x) = 32(°)*	M2 A1	*A partial trigonometric method is M0.* *Accept an answer that rounds to 32(°)*
9.(b) (DE =) 9·4 × sin[22 + 32](°) = 7·6(…)(cm) ISW	M2 A1	FT 22° + 'their 32°'. M0 for using sin22° or sin 'their 32°' alone. M1 for $\frac{DE}{9{\cdot}4}$ = sin54(°) If no marks awarded SC1 for a correct answer (1dp) using their clearly stated or shown angle (D)C(E), but not 22° or 'their 32°'.
Alternative method. ***Correct** use of 'two-step' method.*	M2	*A partial trigonometric method is M0.*

18. (a) 159° and 201° with no other values	B2	B1 for either angle. Check diagram. Penalise -1 for each extra value (beyond 2 attempts). Ignore extra (correct) values outside the required range.
18. (b) (i) Vertical enlargement upwards and downwards	B1	Mark clear intention. Must be the correct shape, i.e. a single cycle of a cosine curve, with x-intercepts at x = 90°and x = 270°, minimum at x = 180°, maxima at x = 0 and x = 360°.
Scale factor of 2	B1	Accept any clear indication. Must have correct x and y-intercepts, correct minimum and correct point for x = 360°.
18. (b) (ii) Vertical translation	B1	Mark clear intention. Must be the correct shape, i.e. a single cycle of a cosine curve, with x-intercepts at x = 0°and x = 360°, minimum at x = 180°, maxima at x = 0 and x = 360°.
Vertical –1	B1	Accept any clear indication. Must have correct x and y-intercepts, correct minimum and correct point for x = 360°. Award SC1 for a fully labelled sketch of y = cos x + 1.

19.(a) $(AE^2 =)\ 8^2 + 11^2 - 2\times8\times11\times\cos31°$ $(AE =)\ 5.8(...\text{cm})$	M1 A2	Award A2 for an answer of 6(cm) from correct working. A1 for $(AE^2 =)\ 34.1(\ldots)$
19.(b) $\sin CAE = \frac{8 \times \sin 31°}{5.8(...)}$ $(CAE =)\ 44.8(\ldots°)$ $(CED =)\ 44.8(\ldots°)$	M2 A1 B1	FT 'their AE' from 19(a). Check the diagram. M1 for $\frac{\sin CAE}{8} = \frac{\sin 31°}{5.8(\ldots)}$ or equivalent Accept answers in the range 44.7° to 45.3°. Strict FT of 'their CAE', provided not 31°. Must be convincing (check the diagram). Accept answers in the range 44.7° to 45.3°.
Alternative method 1 $\cos(CAE) = \frac{11^2+5.8(...)^2-8^2}{2\times11\times5.8(...)}$ *(CAE=) 44.8(…°)* *(CED=) 44.8(…°)*	*M2* *A1* *B1*	FT 'their AE' from 19(a). Check the diagram. *M1 for* $8^2 = 11^2 + 5.8(...)^2 - 2\times11\times5.8(...)\times\cos(CAE)$ *Accept answers in the range 44.7° to 45.3°.* *Strict FT of 'their CAE', provided not 31°. Must be convincing (check the diagram).* *Accept answers in the range 44.7° to 45.3°.*
Alternative method 2 (Initially evaluating CEA) *sin CEA* $= \frac{11 \times \sin 31°}{5.8(...)}$ *OR* *cos CEA* $= \frac{5.8(...)^2 + 8^2 - 11^2}{2\times5.8(...)\times8}$ *(CEA=) 104.1(…) [or 75.8(…) from sine rule]* *(CAE=) 180−31−75.8(…)= 73.2(…) or 180−31−104.1(…)= 44.8(…)* *(CED=) 44.8(…) or 73.2(…)*	*M2* *A1* *B1*	FT 'their AE' from 19(a). Check the diagram. *M1 for* $\frac{\sin CEA}{11} = \frac{\sin 31°}{5.8(...)}$ *or equivalent OR* *M1 for* $11^2 = 5.8(...)^2 + 8^2 - 2\times5.8(...)2\times8\times\cos CEA$ *Accept answers in the range 103.7 to 104.3 or 75.7 to 77.7 OR 78.* *Strict FT of 'their CAE', provided not 31°. Must be convincing (check the diagram).* *Accept answers in the range 44.7° to 45.3°.*

6.(a)	$\frac{1}{2}$	B1	
6.(b)	-3	B1	
6.(c)	(5, 2)	B1	

9.(a) Tan x = $\frac{6{\cdot}4}{8{\cdot}2}$	M1	
(x =) $\tan^{-1}$ 0·78(0..) or $\tan^{-1}\frac{6{\cdot}4}{8{\cdot}2}$	A1	
= 38(°) OR 37·9(...°)	A1	Implies previous A1.
Alternative method.		
***Correct** use of 'two-step' method.*	M2	*A partial trigonometric method is M0.*
(x) = 38(°)	A1	*Accept an answer that rounds to 38(°)*
9.(b) (PAQ = 90 – 38 =) 52(°)	B1	FT 90° − 'their 38°'. May be seen on the diagram.
AQ = $\frac{7{\cdot}9}{\sin 52(°)}$	M2	FT 'their clearly defined PAQ' BUT not if PAQ = 'their x'. M1 for sin52(°) = $\frac{7{\cdot}9}{AQ}$
(AQ) = 10(cm) OR 10·0(…cm)	A1	
Alternative method.		
PQA =*38(°)*	B1	FT 'their 38°'. May be seen on the diagram.
AQ = $\frac{7{\cdot}9}{\cos 38(°)}$	M2	FT 'their clearly defined PQA' M1 for cos 38(°) = $\frac{7{\cdot}9}{AQ}$
(AQ) = 10(cm) OR 10·0(…cm)	A1	
Alternative method.		
(PAQ = 90 – 38 =) 52(°)	*B1*	*FT 90° − 'their 38°'.*
***Correct** use of 'two-step' method.*	*M2*	*A partial trigonometric method is M0.* *FT 'their clearly defined PAQ'* *BUT not if PAQ = 'their x'.*
(AQ) = 10(cm)	*A1*	*Accept an answer that rounds to 10(cm)*

Organisation and Communication	OC1	For OC1, candidates will be expected to: • 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
Accuracy of writing.	W1	For W1, candidates will be expected to: • 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
3.(a) $A \cap B$	B1	
3.(b) B'	B1	
4 Four numbers with a range of 10. Four numbers with a total of 36. Four numbers with a median of 8. Possible answers for all three marks are 5,5,11,15 or 5,6,10,15 or 5,7,9,15 or 5,8,8,15	 B1 B1 B1	B0 if all four original numbers used.
5. (number of females in Porth =) $\frac{90}{360} \times 128$ OR (number of males in Porth =) $\frac{120}{360} \times 72$ (number of females in Porth =) 32 (number of males in Porth =) 24 (Probability from Porth =) $\frac{56}{200}$ or equivalent ISW	M1 A1 A1 A1	Or equivalent *Answers may be seen on the diagram.* An answer of 32 implies M1. An answer of 24 implies M1. FT ('their 32' + 'their 24') /200 provided M1 gained. Penalise incorrect notation −1. e.g. '56 in 200'.
6. sin (QPR) = $\frac{9{\cdot}6}{16{\cdot}7}$ (QPR =) $\sin^{-1}$ (9.6/16·7) or $\sin^{-1}$ (0·57..) = 35·1(°) or 35·09(°) or 35·089(…°)	M1 m1 A1	 Implies M1. Allow any answer that rounds to 35(°)
6.*Alternative method.* ***Correct** use of 'two-step' method.* *(x)* = 35·1(°) or 35·09(°) or 35·089(…°)	 M2 A1	 *A partial trigonometric method is M0.* Allow any answer that rounds to 35(°)
7. 7x + 2y = (£)41.5(0) AND 4x + 3y = (£)29.75 Method to eliminate variable (Attempt at equal coefficients and subtraction) First variable found x =(£) 5 or y = (£)3.25. Substitute to find the 2nd variable. Second variable found.	B1 M1 A1 m1 A1	Allow use of other letters to denote variables. B0 for using 4150 and 2975. FT 'their equations' if of equal difficulty. Allow 1 error in one term, not one with equal coefficients. C.A.O. (for their equations if FT.) F.T. their '1st variable'. FT answers should be given to the nearest penny (rounded or truncated). If M0, award SC2 (with possible B1) for both answers of (£) 5 AND (£)3.25.

	= 80(%)	A1	An answer of 80(%) gains B1M1A1.
5.	MN = 13·5 × cos 27	M2	M1 for cos 27 = $\frac{MN}{13\cdot5}$
	= 12(·0…) (cm) ISW	A1	*A correct and complete method (e.g. using two trigonometric relationships.)* *M2*

9.	$\frac{24 \times AC}{2}$ = 84 or equivalent.	M1	
	AC = 7 (cm)	A1	
	$(BC^2 =)\ 7^2 + 24^2$	M1	F.T. 'their AC'.
	$BC^2 = 625$ or $(BC =)\ \sqrt{625}$	A1	Final answer of BC = 625 is M1A0A0.
	$(BC =)$ 25(cm)	A1	F.T. $\sqrt{}$'their 625' provided M1 gained.
	(Perimeter = 24 + 7 + 25 =) 56(cm)	B1	F.T. 24 + 'their AC' + 'their BC' provided at least one M1 mark gained AND 'their BC' > 24.
			Alternative method to find BC *A correct and complete method (e.g.using two trigonometric relationships.)* *M2* *BC = 25(cm)* *A1*

WJEC GCSE MATHEMATICS

AUTUMN 2020 MARK SCHEME

GCSE Mathematics Unit 2 Higher Tier	Mark	Comments
1.(a) $\frac{1}{6} \times \frac{1}{4}$ or equivalent	M1	
$= \frac{1}{24}$ ISW	A1	Accept 0·0416... or 0·0417 or 0·042 for M1A1 M1A0 for '1 in 24', '1:24'.
1.(b) $\frac{1}{5} + \frac{1}{10}$ or equivalent.	M1	
$= \frac{3}{10}$ or equivalent. ISW	A1	
2. $(AC^2 =)\ 10{\cdot}8^2 + 14{\cdot}4^2$	M1	Accept equivalent of using cos rule (as cos 90 = 0).
$AC^2 = 324$ or $(AC =) \sqrt{324}$	A1	
$(AC =)$ 18(cm)	A1	F.T. √'their 324' provided M1 gained. Final answer of AC = 324 is M1A0A0. *Alternative method to find AC* *A correct and complete method (using two trigonometric relationships)* *M2* *AC = 18(cm)* *A1*
		FT 'their stated AC'. (May be shown on the diagram)
(Area ACD =) $\frac{24 \times 18}{2}$	M1	Accept equivalent of using ½ × 24 × 18 × sin 90 (as sin 90 = 1).
$= 216\ (cm^2)$	A1	
Organisation and Communication	OC1	For OC1, candidates will be expected to: • 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
Accuracy of writing	W1	For W1, candidates will be expected to: • 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.
3.		*Correct evaluation regarded as enough to identify if negative or positive. If evaluations not seen accept 'too high' or 'too low'.* *Look out for equating $x^3 - 5x = 350$*
		x $x^3 - 5x - 350$
One correct evaluation $7{\cdot}2 \le x \le 7{\cdot}3$	B1	
2 correct evaluations $7{\cdot}275 \le x \le 7{\cdot}295$, one < 0, one > 0.	B1	7·2 −12·75(2) 7·21 −11(·2..) 7·22 − 9(·7...) 7·23 − 8(·2...) 7·24 − 6(·6...) 7·25 −5(·1...) 7·26 − 3(·6...) 7·275 −1(·3....) 7·27 − 2(·1...) 7·284 0(·04..)
2 correct evaluations $7{\cdot}275 \le x \le 7{\cdot}285$, one < 0, one > 0.	M1	
$x = 7{\cdot}28$	A1	**7·28 −0·5(7..) 7·285 0·1(9..)** **7·29 0·9(7..)** 7·295 1(·7....) 7·3 2·5(17)

4. $5x - 17 + 2x + 9 + x + 20 = 180$ $8x = 168$ $x = 21$ Substituting x = 21 into at least one expression. $(5x - 17 =)\ 88(°)\ \ (2x + 9 =)\ 51(°)\ \ (x + 20 =)\ 41(°)$ (So not a right-angled triangle)	M1 A1 A1 M1 A1	 F.T. from ax = b. Allow all 3 marks for x = 21. If $x \neq 21$ FT 'their derived value of x'. F.T. for this A1 if $x \geq 4$. Any **two** of these expressions correctly evaluated with no incorrect evaluation, provided the sum of the two found is > 90. (statement not required). *Note* ***If further work indicates that the values found are not treated as angles (e.g. showing $51^2 + 41^2 \neq 88^2$) then award final M0A0.***
Alternative method *$5x - 17 = 90$ OR $2x + 9 = 90$ OR $x + 20 = 90$* *$x = 21{\cdot}4$ AND $x = 40{\cdot}5$ AND $x = 70$* *Then verifying:* *If x = 21·4: $5x - 17 + 2x + 9 + x + 20 = 183.2$* *AND* *If x = 40·5: $5x - 17 + 2x + 9 + x + 20 = 336$* *AND* *If x = 70: $5x - 17 + 2x + 9 + x + 20 = 572$* *(So not a right-angled triangle)*	*M1* *A2* *A2*	*Award A1 for any one of these:* *$x = 21{\cdot}4$ OR $x = 40{\cdot}5$ OR $x = 70$* *Award A1 for any one of these:* *If x = 21·4: $5x - 17 + 2x + 9 + x + 20 = 183.2$* *OR* *If x = 40·5: $5x - 17 + 2x + 9 + x + 20 = 336$* *OR* *If x = 70: $5x - 17 + 2x + 9 + x + 20 = 572$*
5. (AB =) 13·8 × cos 41 OR 13·8 × sin 49 = 10·4(…) (cm)	M2 A1	M1 for $\cos 41 = \frac{AB}{13{\cdot}8}$ OR $\sin 49 = \frac{AB}{13{\cdot}8}$
Alternative method: ***Correct** use of 'two-step' method.* *(AB) = 10·4(…)(cm)*	*M2* *A1*	*A partial trigonometric method is M0.* *Accept an answer that rounds to 10·4(cm)*
6.a(i) $x^3 + 7x$	B2	B1 for sight of x^3 + ……. OR ……+ 7x. Do not accept x×x×x + x×7 etc. Mark final answer.
6(a)(ii) $3x^2 - 4x - 15x + 20$ $3x^2 - 19x + 20$	B1 B1	Must be an expression. FT from an error in only one term (out of 4) only if of the form $ax^2 \pm bx \pm cx \pm d$.
6.(b)(i) $5n - 27 < n$ OR $n > 5n - 27$	B2	Allow B2 for an equivalent correct inequality. e.g. $4n - 27 < 0$. B1 if ≤ or ≥ used in a 'correct' inequality. OR B1 for $5n - 27 > n$ OR $n < 5n - 27$
6.(b)(ii) $4n < 27$ $n < \frac{27}{4}$ (Greatest number of clocks =) 6	B1 B1 B1	FT 'their inequality' if of equivalent difficulty. FT only from an < b OR an ≤ b OR an > b OR an ≥ b. FT only from n < c where c is positive OR n ≤ d where d is positive and not an integer An answer of 6 gains all 3 marks.
7.(a) N ÷ 1·04	B1	
7.(b) 248·832	B2	Allow B2 if 248·832 seen then corrected to a final answer of 249 or 248·8(..). If B2 not awarded, B1 for final answer of 249 or 248·(…) i.e. 248·832 not seen. B1 for sight of $100 \times 1{\cdot}2^5$ or for equivalent calculations, e.g. $144 \times 1{\cdot}2^3$ or 100×1·2×1·2×1·2×1·2×1·2 (may be seen in stages) B1 for a final answer of 298·5984.

17. 218° and 322° with no other values	B2	B1 for either angle. Check diagram. Ignore extra (correct or incorrect) values outside the required range. Penalise -1 for each extra value within range (beyond 2 attempts). If no marks, SC1 for accurate evaluations from consistent use of 180+n AND 360-n (with n acute). Method must be seen for this mark.
18. *(a)* $\frac{4}{7} \times \frac{3}{6} \times \frac{2}{5}$ or equivalent 8/210 (= 4/105)	M1 A1	Penalise once only throughout for a repeated error in calculating the denominator (of 210) ISW
18. *(b)* 1 – P (3, 3, 3) $1 - \frac{4}{7} \times \frac{3}{6} \times \frac{2}{5}$ $\frac{186}{210} \left(= \frac{93}{105} = \frac{62}{70} = \frac{31}{35}\right)$	M1 M1 A1	 ISW If no other marks, award SC1 for an answer of $\frac{279}{343}$ (from working 'with replacement') OR SC1 for sight of $\frac{4}{7} \times \frac{3}{6} \times \frac{2}{5}$
Alternative method *(P(total10)+P(total11)+P(total12)+P(total13)+P(total14)=)* *P(3,3,4) × 3 + P(3,3,5) × 3 + P(3,4,5) × 6 + P(3,5,5) × 3 + P(4,5,5) × 3* $= \frac{4}{7} \times \frac{3}{6} \times \frac{1}{5} \times 3 + \frac{4}{7} \times \frac{3}{6} \times \frac{2}{5} \times 3 + \frac{4}{7} \times \frac{1}{6} \times \frac{2}{5} \times 6 + \frac{4}{7} \times \frac{2}{6} \times \frac{1}{5} \times 3 + \frac{1}{7} \times \frac{2}{6} \times \frac{1}{5} \times 3$ $\frac{186}{210} \left(= \frac{93}{105} = \frac{62}{70} = \frac{31}{35}\right)$	*M1* *M1* *A1*	*M0 if orderings are not considered* *ISW* If no marks awarded, award SC1 for the correct method for calculating any individual total, e.g. P(total 10) = $\frac{4}{7} \times \frac{3}{6} \times \frac{1}{5} \times 3$ or equivalent For information only: *P(10)*= $\frac{36}{210} \left(= \frac{6}{35}\right)$ *P(11)*= $\frac{72}{210} \left(= \frac{12}{35}\right)$ *P(12)*= $\frac{48}{210} \left(= \frac{8}{35}\right)$ *P(13)*= $\frac{24}{210} \left(= \frac{4}{35}\right)$ *P(14)*= $\frac{6}{210} \left(= \frac{1}{35}\right)$ OR award SC1 for a calculation leading to an answer of $\frac{54}{210}$ (from adding probabilities without accounting for different ordering) OR award SC1 for an answer of $\frac{279}{343}$ (from working 'with replacement').

		and 3 (not in a sum).
15. (cos XYZ =) $\frac{34^2 + 55^2 - 73^2}{2\times34\times55}$ ($=\frac{-287}{935}$ OR –0·30695…)	M2	Award M2 for use of cosine rule to find YXZ (= 45·8…°) or XZY (= 26·3…°) AND subsequent use of the sine rule to find the angle XYZ. Award M1 for $73^2 = 34^2 + 55^2 - 2\times34\times55\times\cos$ XYZ
(XYZ =) 107·8(75…°) or 107·9(°) or 108(°)	A1	If no marks awarded, award SC1 for one of the following: • The correct evaluation of either of the two other angles. YXZ = 45·8(…°) and XZY = 26·3(…°) • An answer of XYZ = 72·1(…°) (from 1 slip using the cosine rule). Degrees / Radians / Gradians 107·875… / 1·882… / 119·861… 72·1… / 1·258… / 80·138… 45·8… / 0·799… / 50·901… 26·3… / 0·459… / 29·236…

		• use appropriate terminology, units, etc
5. $YZ = \frac{7}{\cos 41(°)}$ or $7 \div \cos 41(°)$	M2	Award M2 for $YZ = 7 \div \sin 49$ (×sin90) or $\frac{7 (\times \sin 90)}{\sin 49}$ Award M1 for one of the following: • $\cos 41 = \frac{7}{YZ}$ • $\sin 49 = \frac{7}{YZ}$ • $\frac{YZ}{\sin 90} = \frac{7}{\sin 49}$.
= 9·27(…) or 9·28 (cm) or 9.3 (cm)	A1	Accept 9 (cm) from correct working. CAO.
5. Alternative method: ***Correct** use of 'two-step' method.*	*M2*	*A partial trigonometric method is M0.*
= 9·27(…) or 9·28 (cm) or 9.3 (cm)	*A1*	*Accept 9 (cm) from correct working.*

8.(a) $x = \sqrt{25^2 - 10^2}$	B1	
8.(b) $\sin 40° = \frac{y}{25}$	B1	

			On FT solutions must require rounding.
16.	Initially calculating angle **BDC**		
	$\cos BDC = \frac{5^2 + 7^2 - 11^2}{2\times5\times7}$ (= –47/70)	M2	M1 for $11^2 = 5^2 + 7^2 - 2\times5\times7\times\cos BDC$
	(BDC =) 132(·17…°)	A1	The correct angles given in: Radians (2·3038… to 2·3073…) or Gradians (146·6666… to 146·8888…). Allow a trial and improvement method for M2A1 but length of side BC must be in the range 10·95(cm) to 11·05(cm). Sight of 28(·13…°) OR 132(·17…°) OR 19(·68…°), calculated from one use of the rearranged cosine rule in triangle BCD and attributed to the wrong angle, stated or seen on the diagram, is M0 SC1.
	$\sin BAD = \frac{7\times\sin[180-132(\cdot17\ldots°)]}{13}$	M2	FT 'their stated or derived BDC'. M1 for $\frac{\sin BAD}{7} = \frac{\sin[180-132(\cdot17\ldots°)]}{13}$ o.e.
	(BAD =) Answers in the range 23·4(°) to 23·6(°)	A1	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.

16. *Initially calculating angle **BCD***		
$\cos BCD = \frac{5^2 + 11^2 - 7^2}{2\times5\times11}$ (=97/110)	M2	M1 for $7^2 = 5^2 + 11^2 - 2\times5\times11\times\cos BCD$
(BCD =) 28(·13…°)	A1	The correct angles given in: Radians (0·4886… to 0·4911…) or Gradians (31·1111… to 31·2666…). 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). Sight of 28(·13…°) OR 132(·17…°) OR 19(·68…°), calculated from one use of the rearranged cosine rule in triangle BCD and attributed to the wrong angle, stated or seen on the diagram, is M0 SC1.
$\sin BAD = \frac{11\times\sin 28(\cdot13\ldots^\circ)}{13}$	M2	FT 'their stated or derived BCD'. M1 for $\frac{\sin BAD}{11} = \frac{\sin 28(\cdot13\ldots^\circ)}{13}$ o.e.
(BAD =) Answers in the range 23·4(°) to 23·6(°)	A1	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.
Alternative method 2 16. *Multistep method to calculate angle **BDC*** *(First BCD, then CBD or vice versa)*		
$\cos BCD = \frac{5^2 + 11^2 - 7^2}{2\times5\times11}$ (=97/110) OR $\cos CBD = \frac{7^2 + 11^2 - 5^2}{2\times7\times11}$ (=145/154)	M2	A complete, correct method must be seen for the first M2. M1 for one of the following: $7^2 = 5^2 + 11^2 - 2\times5\times11\times\cos BCD$ OR $5^2 = 7^2 + 11^2 - 2\times7\times11\times\cos CBD$
(BCD =) 28(·13…°) OR (CBD =) 19(·68…°) $\sin CBD = \frac{5\times\sin[28(\cdot13\ldots^\circ)]}{7}$ OR $\sin BCD = \frac{7\times\sin 19(\cdot68\ldots^\circ)}{5}$ (CBD =) 19(·68…°) OR (BCD =) 28(·13…°) (BDC =) 180 – [28(·13…°)+19(·68…°)] = 132(·17…°) $\sin BAD = \frac{7\times\sin[180-132(\cdot17\ldots^\circ)]}{13}$	A1 M2	The correct angles given in: Radians (BCD ≈ 0·49 or CBD ≈ 0·34) or Gradians (BCD ≈31·2 or CBD ≈ 21.9). **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 $\frac{\sin BAD}{7} = \frac{\sin[180-132(\cdot17\ldots^\circ)]}{13}$ o.e.
(BAD =) Answers in the range 23·4(°) to 23·6(°)	A1	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.

16. *Multistep method to calculate angle **BDC*** *(First BCD, then BDC OR first CBD, then BDC)*		
$\cos BCD = \frac{5^2 + 11^2 - 7^2}{2\times5\times11}$ (=97/110) OR $\cos CBD = \frac{7^2 + 11^2 - 5^2}{2\times7\times11}$ (=145/154)	M2	A complete, correct method must be seen for the first M2. M1 for one of the following: $7^2 = 5^2 + 11^2 - 2\times5\times11\times\cos BCD$ OR $5^2 = 7^2 + 11^2 - 2\times7\times11\times\cos CBD$
(BCD =) 28(·13…°) OR (CBD =) 19(·68…°)	A1	The correct angles given in: Radians (BCD ≈ 0·49 or CBD ≈ 0·34) Gradians (BCD ≈31·2 or CBD ≈ 21.9).
$\sin BDC = \frac{11\times\sin[28(\cdot13\ldots°)]}{7}$ (=47·82…°) OR $\sin BDC = \frac{11\times\sin 19(\cdot68\ldots°)}{5}$ (=47·82…°)		
(BDC = 180–47(·82…°)) = 132(·17…°)		
$\sin BAD = \frac{7\times\sin[180–132(\cdot17\ldots°)]}{13}$	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 $\frac{\sin BAD}{7} = \frac{\sin[180–132(\cdot17\ldots°)]}{13}$ o.e.
(BAD =) Answers in the range 23·4(°) to 23·6(°)	A1	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.

16. (a) 242° and 298° with no other values	B2	B1 for either angle. Check diagram. Penalise –1 for each extra value within range (beyond 2 attempts). Ignore extra (correct or incorrect) values outside the required range. If only two angles offered and no marks gained, award SC1 for sight of both 180° + 62° and 360° – 62°.

with maximum at (270°, +1), minimum at (90°, –1)		Must be the correct shape, i.e. a single cycle of a negative sine curve, with x-intercepts at $x = 0$, $x = 180°$ and $x = 360°$, minimum at $x = 90°$, maximum at $x = 270°$. Accept any clear indication of y-coordinates. If not B2, award B1 for one of the following: • Fully correct shape and position (both for $0 \le x \le 180°$ and for $180° \le x \le 360°$) without correct coordinates indicated OR • Correct shape and position either for $0 \le x \le 180°$ or for $180° \le x \le 360°$ (a sine curve entirely between $y = -1$ and $y = 1$) AND indication of $y = -1$ and $y = 1$. SC1 for a graph which is fully correct (including labelling) other than having pointed minimum and maximum (formed from straight lines).
16.(b)(ii) Vertical translation +1 with maximum at (90°, +2), minimum at (270°, 0), with y-intercept at +1.	B2	Mark clear intention. Must be the correct shape, i.e. a single cycle of a sine curve, with consistent y values at $x = 0$, $x = 180°$ and $x = 360°$, maximum at $x = 90°$, minimum at $x = 270°$. Accept any clear indication of y-coordinates. Must have correct points for $x = 180°$ and $x = 360°$. 1 and 2 indicated on the y-axis. If not B2, award B1 for one of the following: • Fully correct shape and position (both for $0 \le x \le 180°$ and for $180° \le x \le 360°$) without correct coordinates indicated OR • Correct shape and position either for $0 \le x \le 180°$ or for $180° \le x \le 360°$ (a sine curve entirely between $y = 0$ and $y = 2$) AND indication of $y = 1$ and $y = 2$. SC1 for a graph which is fully correct (including labelling) other than having pointed minimum and maximum (formed from straight lines).

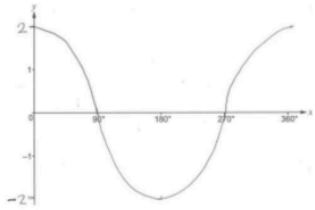
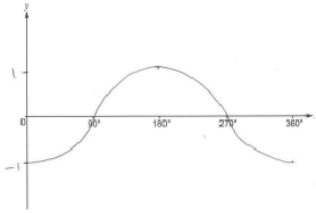
4(a)(i) 440 × 48 ÷ 2.2 9600 (kg)	M1 A1	May be seen in stages Mark final answer Allow answers in the inclusive range 9588 to 9601 from premature approximation Answer space takes precedence
4(a)(ii) 230 000 000 000	B1	
4(b) (Area) 2.47 × 40000 ÷ 10000 or equivalent 9.88 (acres) (Density of trees) 615 ÷ 9.88 62(.2...trees per acre) (>60)	 M1 A1 m1 A1	**Throughout, if 4 marks are awarded, penalise -1 if conclusion 'Yes' is not indicated** **On FT the conclusion may be different to 'Yes'** May be implied in further working Allow 9.8 (acres), 9.9 (acres) or 10 (acres) Depends on M1 m1 previously awarded
4(b) Alternative method 1 *(Area) 2.47 × 40 000 ÷ 10 000 or equivalent* *9.88 (acres)* *(Maximum number of trees) 9.88 × 60* *592(.8) (trees) or 593 (trees) (< 615)*	*M1* *A1* *m1* *A1*	*May be implied in further working* *Allow 9.8 (acres), 9.9 (acres) or 10 (acres)* *Depends on M1 m1 previously awarded* *Allow suitable rounding, e.g. 590 or 600*
4(b) Alternative method 2 *(Area) 2.47 × 40 000 ÷ 10 000 or equivalent* *9.88 (acres)* *(Minimum area) 615 ÷ 60* *10.25 (acres) (> 9.88)*	*M1* *A1* *M1* *A1*	*May be implied in further working* *Allow 9.8 (acres), 9.9 (acres) or 10 (acres)* *Do not allow embedded in further working* *Allow rounded to 10 (acres) provided 'their area' ($9.88m^2$) has not been rounded to 10*
4(b) Alternative method 3 *(Minimum area) 615 ÷ 60* *10.25 (acres)* *(Convert to m^2) 10000 × 10.25 ÷ 2.47* *41497(.97 m^2) or 41498(m^2) (>40000)*	*M1* *A1* *m1* *A1*	*May be implied in further working* *Allow 10 (acres)* *Depends on M1 m1 previously awarded* *Accept suitable rounding, e.g. 41000 or 41500*
4(b) Alternative method 4 *(Trees in 2.47 acres) 615 ÷ (40 000 ÷ 10 000) or equivalent* *153.75 (trees)* *(Density of trees) 153.75 ÷ 2.47* *62(.2...trees per acre) (> 60)*	*M1* *A1* *m1* *A1*	*May be implied in further working* *Allow 153, 153.8 or 154 (trees)* *Depends on M1 m1 previously awarded*
4(b) Alternative method 5 *(Forest area per tree) 40 000 ÷ 615* *65(.0406.. m^2)* *(Fire risk, area per tree) 10 000 ÷ (60 × 2.47)* *67(.476...m^2) (> 65)*	*M1* *A1* *M1* *A1*	*Do not allow embedded in further working*

4(c)(i) (Height of the tree =) $21 \times \tan 39$	M2	*OR alternative full method* M1 for $\tan 39 = \frac{\text{height of tree}}{21}$
17.(…. m)	A1	CAO
4(c)(i) Alternative method 1 *Hypotenuse = 21/cos39* *(= 27.02…)* ***AND** Height* = $\sqrt{(27(.02)^2 - 21^2)}$	*M2*	*M1 for Hypotenuse = 21/cos39* *(= 27.02…)* ***AND** Height*^{2} = $27(.02)^2 - 21^2$
16.9(7…) (m) to 17.(0..m)	*A1*	*CAO*
4(c)(i) Alternative method 2 *(Angle of elevation)* $\tan^{-1}\frac{17}{21}$	*M2*	*M1 tan (elevation)* = $\frac{17}{21}$
38.9(9…°) or 39(°)	*A1*	*CAO*
4(c)(i) Alternative method 3 *(Horizontal distance)* $\frac{17}{\tan 39}$	*M2*	*M1 for tan 39* = $\frac{17}{\text{distance}}$
20.9(98…m) or 21m	*A1*	*CAO*
4(c)(ii) diameter = $\frac{1.75}{\pi}$ or (radius =) $\frac{1.75}{2 \times \pi}$	M2	M1 for any one of the following: • $1.75 = \pi \times$ diameter • $1.75 = 2 \times \pi \times$ radius (Note: radius = $\frac{7}{8\pi}$ m, radius ≈ 0.28m)
(Area of cross section =) $\pi \times (1.75 \div 2\pi)^2$	M1	FT for 'their derived radius' provided it is from a calculation involving the use of π (Note: area of cross section = $\frac{49}{64\pi}$ m^2 area of cross section ≈ 0.24 m^2)
$\times 17 \div 2$	m1	FT provided previous M1 awarded
(Volume) answer in the range 2.07 (m^3) to 2.15 (m^3)	A1	CAO, accept an answer of 2 (m^3) from correct working without sight of premature approximation leading to an answer outside the range

7. Method using angle *XYZ* $YZ = \frac{18{\cdot}6}{\tan 40(°)}$ or $\frac{18{\cdot}6 \times \sin 50}{\sin 40}$ or equivalent $= 22(\cdot 166..)(\text{cm})$	M2 A1	Check diagram for answer. Award M1 for one of the following • $\tan 40(°) = \frac{18{\cdot}6}{YZ}$ • $\frac{YZ}{\sin 50} = \frac{18{\cdot}6}{\sin 40}$ or equivalent Accept an answer rounded or truncated. Award M2A0 for any of the following unsupported answers: Method: $\frac{18{\cdot}6}{\tan 40}$ — Radians: -16·648.... — Gradians: 25·600...
7. Alternative using angle YXZ $YZ = 18{\cdot}6 \times \tan 50(°)$ $= 22(\cdot 166..)(\text{cm})$	*M2* *A1*	*Award M1 for* $\tan 50(°) = \frac{YZ}{18{\cdot}6}$ *Accept an answer rounded or truncated* *Award M2A0 for any of the following unsupported answers:* *Method:* $18{\cdot}6 \times \tan 50$ — *Radians:* -5·057.... — *Gradians:* 18·6
7. Alternative method ***Correct** use of a 'two-step' method.* *22(·166..)(cm) ISW*	*M2* *A1*	*A partial trigonometric method is M0.* *Accept an answer rounded or truncated.*

19. 109° and 289° with no other values	B2	Check diagram. B1 for either angle. Allow embedded answers. Ignore extra (correct or incorrect) values outside the required range. Penalise –1 for each extra value within range (beyond 2 attempts). If no marks, award SC1 for sight of 180–71 AND 360–71 (or equivalent).

17. $3\times\frac{1}{6}\times\frac{1}{6}\times\frac{1}{6}$ or equivalent	M2	M1 for sight of $\frac{1}{6}\times\frac{1}{6}\times\frac{1}{6}\left(=\frac{1}{216}\right)$(one correct product).
$=\frac{3}{216}\left(=\frac{1}{72}\right)$ ISW	A1	Accept decimal answer of 0·0138(8…) OR 0·0139.

18.(a) 122° and 238° with no other values	B2	Check diagram. If B2, penalise –1 for each extra value within range (beyond 2 attempts). Allow embedded answers. B1 for one of the following: • 122° • 238° • sight of both 180 – 58 and 180 + 58 or equivalent. Ignore extra (correct or incorrect) values outside the required range.
18.(b)(i) Vertical stretch (by a factor of 2) Maxima at (0, 2) and (360, 2), Minimum at (180, –2). 	B2	Mark clear intention. Must be the correct shape (including curvature), i.e. a single cycle of a cosine curve, with $y = 0$ at $x = 90°$ and $x = 270°$. Accept any clear indication of y-coordinates. If not B2, award B1 for one of the following: • Fully correct shape and position (for $0 \leq x \leq 360°$) without correct coordinates indicated OR • Correct shape and position either for $0 \leq x \leq 180°$ or for $180° \leq x \leq 360°$ AND indication of $y = 2$ and $y = –2$. OR • A graph which is fully correct (including labelling) other than having pointed minimum and maximum (formed from straight lines).
18.(b)(ii) Reflection in x-axis Minima at (0, –1) and (360, –1), Maximum at (180, 1). 	B2	Mark clear intention. Must be the correct shape (including curvature), i.e. a single cycle of a negative cosine curve, with $y = 0$ at $x = 90°$ and $x = 270°$. Accept any clear indication of y-coordinates. If not B2, award B1 for one of the following: • Fully correct shape and position (for $0 \leq x \leq 360°$) without correct coordinates indicated OR • Correct shape and position either for $0 \leq x \leq 180°$ or for $180° \leq x \leq 360°$ AND indication of $y = 1$ and $y = –1$. OR • A graph which is fully correct (including labelling) other than having pointed minimum and maximum (formed from straight lines).