

Surds

Higher tier

Total marks: 48

Marks

- M** Method mark, for a correct method. It can be implied by a correct answer.
- A** Accuracy mark, for a correct answer. It needs the method mark before it.
- B** A mark for a correct value or statement, with or without working.
- ft** Follow through: the mark is given for using an earlier wrong answer correctly.
- oe** Or equivalent.
- [a, b]** Any value from a to b inclusive.

Questions

Q	Skill	Spec	Tier	Grade	Calculator	Marks
1	Simplifying surds	N8	Higher	6	No	2
2	Rational and irrational numbers	N8	Higher	6	No	2
3	Adding surds	N8	Higher	6	No	2
4	Ordering surds	N8	Higher	7	No	2
5	Rationalising the denominator	N8	Higher	7	No	2
6	Expanding brackets with surds	N8 A4	Higher	7	No	2
7	Squaring a sum of surds: is the claim correct	N8 A4	Higher	7	No	2
8	Simplifying a fraction of surds: show that	N8	Higher	7	No	3
9	Writing a surd as a power	N8 N7	Higher	8	No	2
10	Finding an unknown in a surd expression	N8 A4	Higher	8	No	3
11	Surds with Pythagoras and area	N8 G20 A4	Higher	8	No	5
12	Exact area of an equilateral triangle	N8 G20	Higher	8	No	3
13	Rationalising in context: width from the area	N8	Higher	8	No	4
14	Solving an equation with surds	N8 A17	Higher	9	No	4
15	Surds in 3D: show that a cuboid is a cube	N8 G20 A4	Higher	9	No	6
16	Rationalising and expanding powers of surds	N8 A4	Higher	9	No	4
	Total					48

Question 1 N8 · Higher · Grade 6 · 2 marks

Q	Answer	Mark	Comments
1(a)	$6\sqrt{2}$	B1	
1(b)	$\sqrt{45}$	B1	

Question 2 N8 · Higher · Grade 6 · 2 marks

Q	Answer	Mark	Comments
2(a)	$\sqrt{8}$	B1	
2(b)	any correct pair	B1	such as $\sqrt{2}$ and $\sqrt{18}$, $\sqrt{3}$ and $\sqrt{12}$, $\sqrt{3}$ and $2\sqrt{3}$, $\sqrt{\frac{1}{2}}$ and $\sqrt{72}$

Question 3 N8 · Higher · Grade 6 · 2 marks

Q	Answer	Mark	Comments
3	$5\sqrt{2}$ or $3\sqrt{2}$	M1	
	$8\sqrt{2}$	A1	

Question 4 N8 · Higher · Grade 7 · 2 marks

Q	Answer	Mark	Comments
4	two of $\sqrt{28}$, $\sqrt{27}$, $\sqrt{32}$	M1	or squares 28, 27, 32 and 30
	$3\sqrt{3}$, $2\sqrt{7}$, $\sqrt{30}$, $4\sqrt{2}$	A1	

Question 5 N8 · Higher · Grade 7 · 2 marks

Q	Answer	Mark	Comments
5	$\frac{12\sqrt{3}}{3}$ or $\frac{12}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$	M1	oe
	$4\sqrt{3}$	A1	

Question 6 N8 A4 · Higher · Grade 7 · 2 marks

Q	Answer	Mark	Comments
6	three of 6, $-3\sqrt{5}$, $+2\sqrt{5}$, -5	M1	terms may be in a grid
	$1 - \sqrt{5}$	A1	

Question 7 N8 A4 · Higher · Grade 7 · 2 marks

Q	Answer	Mark	Comments
7	$3 + \sqrt{6} + \sqrt{6} + 2$	M1	oe, four terms with at least three correct
	No and $5 + 2\sqrt{6}$	A1	oe

Question 8 N8 · Higher · Grade 7 · 3 marks

Q	Answer	Mark	Comments
8	two of $3\sqrt{3}$, $2\sqrt{3}$, $5\sqrt{3}$, $4\sqrt{3}$	M1	
	$\frac{5\sqrt{3}}{\sqrt{3}}$	M1	oe
	= 5	A1	a full method with no errors

Question 9 N8 N7 · Higher · Grade 8 · 2 marks

Q	Answer	Mark	Comments
9	$8 = 2^3$ and $\sqrt{2} = 2^{\frac{1}{2}}$	M1	oe, or $(8\sqrt{2})^2 = 128 = 2^7$
	$\frac{7}{2}$	A1	oe, such as 3.5 or $3\frac{1}{2}$

Question 10 N8 A4 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
10	$a + 2\sqrt{3}\sqrt{a} + 3$	M1	oe, such as $a + 2\sqrt{(3a)} + 3$
	$a + 3 = 19$ or $2\sqrt{(3a)} = 8\sqrt{3}$	M1	oe
	16	A1	

Question 11 N8 G20 A4 · Higher · Grade 8 · 5 marks

Q	Answer	Mark	Comments
11(a)	$\frac{1}{2} \times (4 + \sqrt{2})(4 - \sqrt{2})$	M1	oe
	$\frac{1}{2} \times (16 - 2) = 7$	A1	with $16 - 4\sqrt{2} + 4\sqrt{2} - 2$ or $16 - 2$ seen
11(b)	$(4 + \sqrt{2})^2 = 18 + 8\sqrt{2}$ or $(4 - \sqrt{2})^2 = 18 - 8\sqrt{2}$	M1	oe, one expanded correctly
	$18 + 8\sqrt{2} + 18 - 8\sqrt{2} = 36$	M1	oe, the sum of their squares
	$\sqrt{36} = 6$	A1	a full method with no errors

Question 12 N8 G20 · Higher · Grade 8 · 3 marks

Q	Answer	Mark	Comments
12	$h^2 = (2\sqrt{3})^2 - (\sqrt{3})^2$ or $12 - 3$	M1	oe, the height by Pythagoras
	$\frac{1}{2} \times 2\sqrt{3} \times 3$	M1	oe, ft their height
	$3\sqrt{3}$	A1	

Question 13 N8 · Higher · Grade 8 · 4 marks

Q	Answer	Mark	Comments
13(a)	$\frac{20}{5+\sqrt{5}}$	M1	oe
	$\frac{20}{5+\sqrt{5}} \times \frac{5-\sqrt{5}}{5-\sqrt{5}}$ or $\frac{20(5-\sqrt{5})}{20}$	M1	oe
	$5 - \sqrt{5}$	A1	
13(b)	$2(5 + \sqrt{5} + 5 - \sqrt{5}) = 20$	B1	oe, a full method using a correct width

Question 14 N8 A17 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
14	$x\sqrt{3} - x = 2\sqrt{3} - 4$	M1	oe, collects the x terms
	$x = \frac{2\sqrt{3}-4}{\sqrt{3}-1}$	M1	oe, factorises and divides
	$\frac{2\sqrt{3}-4}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1}$	M1	oe, or numerator $6 + 2\sqrt{3} - 4\sqrt{3} - 4 = 2 - 2\sqrt{3}$
	$1 - \sqrt{3}$	A1	

Question 15 N8 G20 A4 · Higher · Grade 9 · 6 marks

Q	Answer	Mark	Comments
15(a)	$(1 + \sqrt{3})^2 = 4 + 2\sqrt{3}$	M1	oe, the area of the base
	$\frac{10+6\sqrt{3}}{4+2\sqrt{3}}$	M1	oe, the volume divided by the area of the base
	$\frac{10+6\sqrt{3}}{4+2\sqrt{3}} \times \frac{4-2\sqrt{3}}{4-2\sqrt{3}}$	M1	oe, or numerator $40 - 20\sqrt{3} + 24\sqrt{3} - 36 = 4 + 4\sqrt{3}$ and denominator 4
	height = $1 + \sqrt{3}$, the same as the sides of the base	A1	a full method with no errors; or $(1 + \sqrt{3})^3 = 10 + 6\sqrt{3}$ shown in full for M3 A1
15(b)	$\sqrt{3} \times (1 + \sqrt{3})$ or $\sqrt{(3(4 + 2\sqrt{3}))}$ or $\sqrt{(12 + 6\sqrt{3})}$	M1	oe, Pythagoras in 3D
	$3 + \sqrt{3}$	A1	

Question 16

N8 A4 · Higher · Grade 9 · 4 marks

Q	Answer	Mark	Comments
16	$p = 2 - \sqrt{3}$ or $q = 2 + \sqrt{3}$	M1	oe, one denominator rationalised
	$(2 - \sqrt{3})^2 = 7 - 4\sqrt{3}$ or $(2 + \sqrt{3})^2 = 7 + 4\sqrt{3}$	M1	oe, or $p + q = 4$ and $pq = 1$
	$26 - 15\sqrt{3}$ or $26 + 15\sqrt{3}$	M1	oe, one cube expanded, or $4^3 - 3 \times 1 \times 4$
	52	A1	