



## Unit 1 Revision Sheet A Fractions Decimal Percentages Higher

**Note: Higher tier students must also revise using the foundation tier revision worksheets as this content can also be assessed on higher tier papers.**

### Questions

**Q1.**

(a) Work out 39% of 450

(2)

(b) Write one pair of brackets in this calculation so that the answer is correct.

$$9 \times 8 - 5 - 2 = 25$$

(1)

(c) Work out the value of  $\frac{\sqrt{8.9}}{6.2 - 3.5}$

Give your answer as a decimal.

Write down all the figures on your calculator display.

(2)

**(Total for question = 5 marks)**

**Q2.**

Write  $3.6 \times 10^3$  as a product of powers of its prime factors.  
Show your working clearly.

**(Total for question = 3 marks)**

**Q3.**

Write 600 as a product of powers of its prime factors.  
Show your working clearly.

**(Total for question = 3 marks)**



**Q4.**

$$\frac{2.14^3 - 3.76}{\sqrt{1.24}}$$

- (a) Use your calculator to work out the value of

Write down all the figures on your calculator display.

(2)

- (b) Write your answer to part(a) correct to 2 significant figures.

(1)

**(Total for question = 3 marks)**

**Q5.**

The length of a fence is 137 metres, correct to the nearest metre.

Write down

- (i) the lower bound for the length of the fence,
- (ii) the upper bound for the length of the fence.

**(Total for question = 2 marks)**

**Q6.**

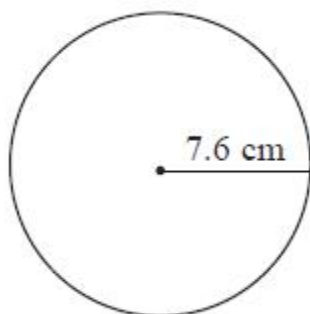


Diagram **NOT**  
accurately drawn

- (a) A circle has a radius of 7.6 cm.

Work out the area of the circle.

Give your answer correct to 3 significant figures.

(2)

The radius, 7.6 cm, is correct to 1 decimal place.

- (b) (i) Write down the upper bound of the radius.

- (ii) Write down the lower bound of the radius.

(2)

**(Total for Question is 4 marks)**



**Q7.**

Each side of a regular octagon has a length of 18 mm, correct to the nearest 0.5 mm

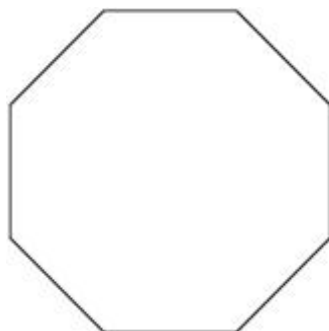


Diagram **NOT**  
accurately drawn

(a) Write down the lower bound of the length of each side of the octagon.

(1)

(b) Write down the upper bound of the length of each side of the octagon.

(1)

**(Total for question = 2 marks)**

**Q8.**

(a) Find the value of the cube of 4

(1)

(b) Write  $3 \times 3 \times 3 \times 3 \times 3$  as a single power of 3

(1)

(c) Write  $\frac{7^5 \times 7^9}{7^6}$  as a single power of 7

(2)

**(Total for Question is 4 marks)**

**Q9.**

(a) Express 600 as a product of powers of its prime factors.  
Show your working clearly.

(3)

(b) Simplify  $\frac{5^{12}}{5^2 \times 5}$   
Give your answer as a power of 5

(2)

**(Total for question = 5 marks)**



**Q10.**

(a) Simplify  $(4^{-2})^0$

(1)

$$3^{-14} \times 3^8 = 3^m$$

(b) Find the value of  $m$

(1)

**(Total for question = 2 marks)**

**Q11.**

$$\frac{8}{2^7} = 2^n$$

(a) Find the value of  $n$ .

(2)

$$(13^{-6})^4 \times 13^5 = 13^k$$

(b) Find the value of  $k$ .

(2)

**(Total for question = 4 marks)**

**Q12.**

$$\frac{2^k}{4^n} = 2^x$$

Find an expression for  $x$  in terms of  $k$  and  $n$

**(Total for question = 2 marks)**



**Q13.**

Find the values of  $n$  such that

$$\frac{10^{4n} \times 2^{3(n^2-5n)} \times 5^{2(1-2n)}}{20^2} = 1$$

Show clear algebraic working.

**(Total for question = 5 marks)**

**Q14.**

Simplify 
$$\frac{30 \times 25^{2x+7}}{\sqrt{180} \times (\sqrt{5})^{4x+9}}$$

Give your answer in the form  $5^w$  where  $w$  is an expression in terms of  $x$

Show each stage of your working clearly.

**(Total for question = 3 marks)**

**Q15.**

(a) Write down the value of  $m$ , given that  $3^4 \times 3^5 = 3^m$

(1)

(b) Write down the value of  $n$ , given that  $(5^3)^7 = 5n$

(1)

(c) Find the value of  $p$ , given that 
$$\frac{7^8 \times 7^2}{7^p}$$

(2)

**(Total for question = 4 marks)**

**Q16.**

Express  $\sqrt{48} + \sqrt{108}$  in the form  $k\sqrt{6}$  is a surd

**(Total for question = 3 marks)**



**Q17.**

$(a + \sqrt{b})^2 = 49 + 12\sqrt{b}$  where  $a$  and  $b$  are integers, and  $b$  is prime.

Find the value of  $a$  and the value of  $b$

**(Total for question = 3 marks)**

**Q18.**

(a) Show that  $(3 + 2\sqrt{2})(4 - \sqrt{2}) = 8 + 5\sqrt{2}$

Show your working clearly.

(2)

(b) Rationalise the denominator and simplify fully  $\frac{10 + 3\sqrt{2}}{\sqrt{2}}$

Show your working clearly.

(2)

**(Total for question = 4 marks)**

**Q19.**

Without using a calculator, show that  $\frac{12}{\sqrt{2} - 1} - (\sqrt{2})^5 = 2\sqrt{32} + 12$

Show your working clearly.

**(Total for question = 3 marks)**

**Q20.**

(a) Use algebra to show that  $0.\dot{3}\dot{2}\dot{4} = \frac{107}{330}$

(2)



(b) Rationalise the denominator of  $\frac{4}{7 - \sqrt{5}}$

Show each stage of your working.

Give your answer in the form  $a + b\sqrt{5}$  where  $a$  and  $b$  are fractions in their simplest forms.

(3)

(Total for question = 5 marks)

**Q21.**

(a) Expand  $(5 + 3\sqrt{2})^2$

Give your answer in the form  $(a + b\sqrt{2})$ , where  $a$  and  $b$  are integers.  
Show your working clearly.

(2)

(b)  $(5 + 3\sqrt{2})^2 = p + \frac{q}{\sqrt{8}}$ , where  $p$  and  $q$  are integers.

Find the value of  $q$ .

(3)

(Total for Question is 5 marks)

**Q22.**

Without using a calculator, rationalise the denominator of  $\frac{6}{3 - \sqrt{7}}$

Simplify your answer.

You must show each stage of your working.

(Total for question = 3 marks)

**Q23.**

A metal block has a mass of 5 kg, correct to the nearest 50 grams.  
The block has a volume of  $(1.84 \times 10^{-3}) \text{ m}^3$ , correct to 3 significant figures.

Work out the upper bound for the density of the block.

Give your answer in  $\text{kg/m}^3$  correct to 1 decimal place.

Show your working clearly.

(Total for question = 4 marks)



**Q24.**

Diego builds a fence using fence panels.

The total length of the fence is 50 metres, correct to the nearest 5 metres.

The length of each fence panel is 1.3 metres, correct to the nearest 10 cm.

The cost of each fence panel is £8.65

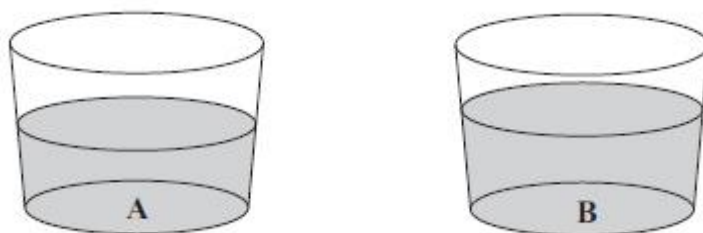
Diego may only buy complete fence panels.

Diego only pays for the number of panels he needs to build the fence.

Work out the greatest difference in the possible amounts that Diego could pay to build the fence.  
Show your working clearly.

**(Total for question = 4 marks)**

**Q25.**



Glass **A** contains 122 millilitres of water, correct to the nearest millilitre.

Glass **B** contains 168 millilitres of water, correct to the nearest millilitre.

Calculate the upper bound of the difference, in millilitres, between the volume of water in glass **A** and the volume of water in glass **B**.

**(Total for question = 2 marks)**

**Q26.**

$y = 1.8$  correct to 1 decimal place.

Calculate the lower bound for the value of  $4y + 1$

**(Total for question = 2 marks)**

**Q27.**

The length of a table is measured as 1.4 metres correct to one decimal place.

(a) Write down the upper bound of the length of the table.

(1)

(b) Write down the lower bound of the length of the table.

(1)

**(Total for question = 2 marks)**





## Mark Scheme

Q1.

Q	Working	Answer	Mark	Notes
(a)	$0.39 \times 450$ or $\frac{39}{100} \times 450$ or $\frac{450}{100} \times 39$ oe eg $3 \times 45 + 9 \times 4.5$ oe		2	M1
	<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	175.5		A1
(b)		Brackets around $(8 - 5)$	1	B1 $9 \times (8 - 5) - 2 = 25$ with no incorrect brackets, condone eg $(9 \times (8 - 5)) - 2 = 25$ which has extra brackets that are not incorrect
(c)		1.1049(21029)	2	B2 for 1.1049(21029) ie 5 sf or better truncated or rounded (B1 for 2.98... or 2.7)
				<b>Total 5 marks</b>

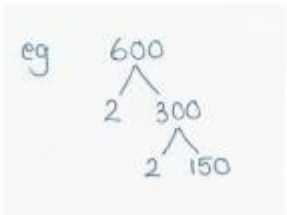
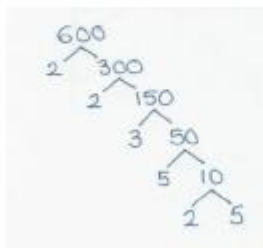


Q2.

Q	Working	Answer	Mark	Notes																		
	<p>E.g.  <math>2 \times 2 \times 900</math> or <math>2^2 \times 900</math> or <math>2 \times 3 \times 600</math> or  <math>2 \times 5 \times 360</math> or <math>3 \times 3 \times 400</math> or <math>3^2 \times 400</math> or  <math>3 \times 5 \times 240</math> or <math>5 \times 5 \times 144</math> or <math>5^2 \times 144</math></p> <p>E.g.</p> <table border="1"> <tr><td>2</td><td>3600</td></tr> <tr><td>2</td><td>1800</td></tr> <tr><td></td><td>900</td></tr> </table> <p>E.g.</p> <pre>       3600      /  \     2    1800        /  \       2    900   </pre>	2	3600	2	1800		900		3	<p>M1 for at least 2 correct stages in prime factorisation which give 2 prime factors – may be in a factor tree or a table or listed eg 2, 2, 900</p> <p>(see LHS for examples of the amount of work needed for the award of this mark, allow no more than one mistake ft in factor tree or table</p> <p>(eg one mistake with 2 prime factors ft: <math>3600 = 1800 \times 20 = 2 \times 900 \times 4 \times 5</math> or <math>360 = 2 \times 2 \times 90</math>)</p>												
2	3600																					
2	1800																					
	900																					
	<p>E.g. <math>2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5</math></p> <p>E.g.</p> <table border="1"> <tr><td>2</td><td>3600</td></tr> <tr><td>2</td><td>1800</td></tr> <tr><td>2</td><td>900</td></tr> <tr><td>2</td><td>450</td></tr> <tr><td>3</td><td>225</td></tr> <tr><td>3</td><td>75</td></tr> <tr><td>5</td><td>25</td></tr> <tr><td>5</td><td>5</td></tr> <tr><td></td><td>(1)</td></tr> </table> <p>E.g.</p> <pre>       3600      /  \     2    1800        /  \       2    900          /  \         2    450            /  \           2    225              /  \             3    75                /  \               3    25                  /  \                 5    5   </pre>	2	3600	2	1800	2	900	2	450	3	225	3	75	5	25	5	5		(1)			<p>M1 for 2, 2, 2, 2, 3, 3, 5, 5 or <math>2^4, 3^2, 5^2</math> or <math>2^4 + 3^2 + 5^2</math> (ignore 1s) (may be a fully correct factor tree or ladder)</p>
2	3600																					
2	1800																					
2	900																					
2	450																					
3	225																					
3	75																					
5	25																					
5	5																					
	(1)																					
	Working required	$2^4 \times 3^2 \times 5^2$		<p>A1 dep on M2</p> <p>can be any order (allow <math>2^4 \cdot 3^2 \cdot 5^2</math>)</p> <p>(SCB1 for <math>3.6 \times 2^3 \times 5^3</math>)</p>																		
				<b>Total 3 marks</b>																		



Q3.

Q	Working	Answer	Mark	Notes														
	<p>eg <math>2 \times 2 \times 150</math> or <math>3 \times 5 \times 40</math> or <math>2 \times 3 \times 100</math> or <math>5^2 \times 24</math> or</p> <p>eg  or</p> <p>eg <table border="1" data-bbox="221 781 469 904"><tr><td>2</td><td>600</td></tr><tr><td>2</td><td>300</td></tr><tr><td></td><td>150</td></tr></table></p>	2	600	2	300		150		3	M1 for at least 2 correct stages in prime factorisation which give 2 prime factors – may be in a factor tree or a table or listed eg 2, 2, 150 (see LHS for examples of the amount of work needed for the award of this mark, allow no more than one mistake ft (eg one mistake with 2 prime factors ft: $600 = 200 \times 30 = 2 \times 100 \times 5 \times 6$ )								
2	600																	
2	300																	
	150																	
	<p>eg <math>2 \times 2 \times 2 \times 3 \times 5 \times 5</math></p> <p> oe</p> <table border="1" data-bbox="205 1330 381 1599"><tr><td>2</td><td>600</td></tr><tr><td>2</td><td>300</td></tr><tr><td>2</td><td>150</td></tr><tr><td>3</td><td>75</td></tr><tr><td>5</td><td>25</td></tr><tr><td>5</td><td>5</td></tr><tr><td></td><td>[1]</td></tr></table> oe	2	600	2	300	2	150	3	75	5	25	5	5		[1]			M1 for 2, 2, 2, 3, 5, 5 (ignore 1s) (may be a fully correct factor tree or ladder)
2	600																	
2	300																	
2	150																	
3	75																	
5	25																	
5	5																	
	[1]																	
	<p>Working required. NB: answer must be given as a product of powers of prime factors</p>	$2^3 \times 3 \times 5$		A1 dep on M2 can be any order (allow $2^3 \cdot 3 \cdot 5^2$ )														
Total 3 marks																		



Q4.

Question	Working	Answer	Mark	Notes
(a)	$\frac{6.04(0344...)}{1.11(3552873...)}$		2	M1 Either numerator or denominator correct (at least 3 digits needed) or for an answer of 5.42 to 5.4243 rounded or truncated.
		5.4243(89042...)		A1 accept 5.4243 or 5.4244 or better.
(b)		5.4	1	B1ft ft their answer to (a), must have at least 3 sig figs in part (a)
Total 3 marks				

Q5.

Q	Working	Answer	Mark	Notes
(i)		136.5	1	B1
(ii)		137.5 or 137.499..	1	B1 At least 137.499 or better
Total 2 marks				

Q6.

Question	Working	Answer	Mark	Notes
(a)	$\pi \times 7.6^2$			M1
		181	2	A1 181(.4583...) accept answers 181 – 182 inclusive
(b) (i)		7.65	1	B1 accept 7.649
(ii)		7.55	1	B1
Total 4 marks				

Q7.

Q	Working	Answer	Mark	Notes
(a)		17.75	1	B1 oe
(b)		18.25	1	B1 oe 18.249 (allow 18.2499...)
				SC B1 for 17.5 in (a) and 18.5 (or 18.49) in (b)
Total 2 marks				



**Q8.**

Question	Working	Answer	Mark	Notes
(a)		64	1	B1 cao
(b)		$3^5$	1	B1 cao
(c)	$\frac{7^{14}}{7^6}$ or $\frac{7^9}{7^{(1)}}$ or $7^5 \times 7^3$	$7^8$	2	M1 A1
<b>Total 4 marks</b>				

**Q9.**

Question	Working	Answer	Mark	Notes
(a)	Correct factor tree or repeated division to find factors 2, 2, 2, 3, 5, 5 (condone inclusion of 1's)		3	M2 for finding correct factors (condone the inclusion of 1) M1 for finding a set of factors (with a product of 600) which includes at least 3 of the six prime factors. This may be a factor tree that is incomplete or only correct to this stage, for instance.
		$2^3 \times 3 \times 5^2$		A1 dep on M2
(b)	$\frac{5^{12}}{5^3}$ or $\frac{5^{10}}{5}$ or $\frac{5^{11}}{5^2}$		2	M1 For a correct application of an index law.
		$5^9$		A1
<b>Total 5 marks</b>				

**Q10.**

(a)		1	1	B1 cao
(b)		-6	1	B1 Allow $3^{-6}$
<b>Total 2 marks</b>				





Q11.

Question	Working	Answer	Mark	Notes
(a)	$\frac{2^3}{2^7}$ or $2^3 \times 2^{-7}$ or $\frac{1}{2^4}$ or ( $\frac{1}{16}$ and $16 = 2^4$ )	-4	2	M1 A1 Accept $2^{-4}$
(b)	$13^{-24} \times 13^5$	-19	2	M1 for $13^{-24}$ or for $k = -6 \times 4 + 5$ A1 Accept $13^{-19}$ <b>Total 4 marks</b>

Q12.

Q	Working	Answer	Mark	Notes
	$(4^n =)(2^2)^n$ or $(4^n =)2^{2n}$ oe eg $2^k \div 2^{2n} = 2^x$ or $2^k = 4^{\frac{1}{2}k}$ and $2^x = 4^{\frac{1}{2}x}$ oe eg $\frac{4^{\frac{1}{2}k}}{4^n} = 4^{\frac{1}{2}x}$		2	M1 for writing $4^n$ as $(2^2)^n$ or $2^{2n}$ or for writing each term in terms of 4 ie $2^k = 4^{\frac{1}{2}k}$ and $2^x = 4^{\frac{1}{2}x}$  If these things are seen in working, award this mark even if followed by incorrect working – if not a choice of methods
		$k - 2n$		A1 allow $2^{k-2n}$
				<b>Total 2 marks</b>



Q13.

Q	Working	Answer	Mark	Notes
	<p>For one of:</p> $10^{4n} = (5 \times 2)^{4n}$ or $5^{4n} \times 2^{4n}$ or oe $20^2 = (5 \times 2^2)^2$ or $5^2 \times 2^4$ or $5^2 \times 2^2 \times 2^2$ or cancelling $5^2$ on numerator with $20^2$ to get 16 or $2^4$		5	<p>M1 for writing <math>10^{4n}</math> correctly as a product of 5 and 2 to the power <math>4n</math> oe  or  writing <math>20^2</math> correctly as a product of 5 and <math>2^2</math> to the power 2 oe  or  cancelling <math>5^2</math> on numerator with <math>20^2</math> to get 16 or <math>2^4</math></p>
	<p>for getting numerator to the stage (this scores M1M1)</p> $2^{4n} \times 2^{3n^2-15n} \times 5^2$ oe eg $2^{3n^2-11n} \times 5^{-4n+4n+2}$ oe or for two of $10^{4n} = (5 \times 2)^{4n}$ or $5^{4n} \times 2^{4n}$ or oe $20^2 = (5 \times 2^2)^2$ or $5^2 \times 2^4$ or $5^2 \times 2^2 \times 2^2$ or cancelling $5^2$ on numerator with $20^2$ to get 16 or $2^4$ or getting the numerator to the stage			M1
	$\frac{2^{4n} \times 2^{3n^2} \times 2^{-15n}}{2^4} [= 1 \text{ or } 2^0] \text{ or}$ $2^{4n} \times 2^{3n^2} \times 2^{-15n} = 2^4$ oe			M1 For writing the equation in powers of 2 only
	$3n^2 - 11n - 4 [= 0]$			A1 Correct quadratic equation dep on M1
	working required	$-\frac{1}{3}, 4$		A1 Both answers required dep on M1
				Total 5 marks



Q14.

Q	Working	Answer	Mark	Notes
	<p><b>For 2 of</b></p> <p><math>30 = 5 \times 6</math> or <math>30 = 5 \times 2 \times 3</math> oe (for numerator)</p> <p>or</p> <p><math>\sqrt{180} = 6\sqrt{5}</math> oe or <math>\sqrt{180} = 2 \times 3 \times \sqrt{5}</math> (for denominator)</p> <p>or</p> <p><math>25^{2x+7} = (5^2)^{2x+7}</math> or <math>5^{2(2x+7)}</math> oe</p> <p>or</p> <p><math>(\sqrt{5})^{4x+9} = \left(5^{\frac{1}{2}}\right)^{4x+9}</math> or <math>5^{\frac{1}{2}(4x+9)}</math> oe</p> <p>or</p> <p><math>\frac{30}{\sqrt{180}} = \sqrt{5}</math> oe</p> <p>or <math>5^{4x+15}</math> as the numerator</p> <p>or <math>5^{2x+5}</math> as the denominator</p>		3	<p>M1 or <math>5^{4x+15}</math> as the numerator or <math>5^{2x+5}</math> as the denominator or <math>30 = 5 \times 6</math> or <math>30 = 5 \times 2 \times 3</math> oe or <math>\sqrt{180} = 6\sqrt{5}</math> oe or <math>\sqrt{180} = 2 \times 3 \times \sqrt{5}</math> or <math>25^{2x+7} = (5^2)^{2x+7}</math> or <math>5^{2(2x+7)}</math> oe or <math>(\sqrt{5})^{4x+9} = \left(5^{\frac{1}{2}}\right)^{4x+9}</math> or <math>5^{\frac{1}{2}(4x+9)}</math> oe or</p>
	<p><math>\frac{6 \times 5 \times 5^{4x+14}}{6 \times 5^{0.5} \times 5^{2x+4.5}}</math> oe eg <math>\frac{5^{4x+15}}{5^{2x+5}}</math> or</p> <p><math>\frac{\sqrt{5}^{8x+10}}{\sqrt{5}^{4x+10}}</math> oe or <math>\frac{25^{2x+7.5}}{25^{x+2.5}}</math> oe</p>			<p>M1 Correct expression in terms of 6 (or 2 and 3) and 5 with indices Some cancellation could have taken place or fully correct with <math>\sqrt{5}</math> and powers or 25 and powers</p>
	working required	$5^{2x+10}$		<p>A1 dep on M2 allow <math>w = 2x + 10</math></p>
Total 3 marks				

Q15.

Q	Working	Answer	Mark	Notes
(a)		9	1	B1 allow $3^9$
(b)		21	1	B1 allow $5^{21}$
(c)	<p><math>8 + 2 - p = 6</math> oe eg <math>8 + 2 = 6 + p</math> or</p> <p><math>7^{8+2-p} = 7^6</math> oe</p>		2	M1 (or embedded eg $8 + 2 = 10$ , $10 - 4 = 6$ )
	Correct answer scores full marks (unless from obvious incorrect working)	4		A1 allow $7^4$
Total 4 marks				





Q16.

Q	Working	Answer	Mark	Notes
	$\sqrt{8 \times 6} + \sqrt{18 \times 6}$ $(2\sqrt{2} \times \sqrt{6}) + (3\sqrt{2} \times \sqrt{6})$	must see intention to add  $(k=) \sqrt{50}$ or $5\sqrt{2}$ or $\frac{10}{\sqrt{2}}$	M1 M1 A1	or $\sqrt{16 \times 3} + \sqrt{36 \times 3}$ ( $= 10\sqrt{3}$ ) $10\sqrt{3} \times \frac{\sqrt{2}}{\sqrt{2}}$ or $\frac{10\sqrt{3}}{\sqrt{6}}$ dep on at least 1 M1 sight of decimals <i>used in working</i> loses M marks at that stage and A mark  or $\sqrt{4 \times 12} + \sqrt{9 \times 12}$ ( $= 5\sqrt{12}$ ) $5\sqrt{12} \times \frac{\sqrt{2}}{\sqrt{2}}$ or $5 \times \sqrt{(6 \times 2)}$
				Total 3 marks

Q17.

Question	Working	Answer	Mark	Notes
	$a^2 + a\sqrt{b} + a\sqrt{b} + b$ or $a^2 + a\sqrt{b} + a\sqrt{b} + (\sqrt{b})^2$			M1 Correct expansion
		6		A1 For $a$
		13	3	A1 For $b$
				Total 3 marks



Q18.

Ques	Working	Answer	Mark	Notes
a	$12 - 3\sqrt{2} + 8\sqrt{2} - 2\sqrt{2} \times \sqrt{2}$ or $12 - 3\sqrt{2} + 8\sqrt{2} - 2 \times 2$ or $12 - 3\sqrt{2} + 8\sqrt{2} - 4$		2	M1 for any 3 terms correct of a 4 term expansion
		$8 + 5\sqrt{2}$		A1 dep on M1 with all necessary steps shown
b	$\frac{10 + 3\sqrt{2}}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$ or $\frac{10}{\sqrt{2}} + 3 = \frac{10}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} + 3$		2	M1 for a correct method to rationalise denominator
		$5\sqrt{2} + 3$		A1 dep on M1 with all necessary steps shown
				<b>Total 4 marks</b>



Q19.

Q	Working	Answer	Mark	Notes
	$\frac{12}{\sqrt{2}-1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1} \text{ or } \frac{12}{\sqrt{2}-1} \times \frac{-\sqrt{2}-1}{-\sqrt{2}-1}$ <p>and</p> $4\sqrt{2} \text{ or } 2\sqrt{8} \text{ or } \sqrt{32} \text{ oe}$		3	M1 for showing a correct method for rationalising the denominator and dealing with $(\sqrt{2})^5$
	<p>E.g. <math>12\sqrt{2}+12-4\sqrt{2}</math> or <math>8\sqrt{2}+12</math></p> $12\sqrt{2}+12-2\sqrt{8} \text{ or}$ $12\sqrt{2}+12-\sqrt{32} \text{ oe}$			M1 dep expression must be in surd form
	<p>E.g. <math>12\sqrt{2}(+12)-4\sqrt{2}=8\sqrt{2}(+12)=</math></p> $2\sqrt{4^2 \times 2}(+12)=2\sqrt{32}(+12)$ <p>or</p> $12\sqrt{2}(+12)-2\sqrt{8}=6\sqrt{8}(+12)-2\sqrt{8}=4\sqrt{8}(+12)=$ $2\sqrt{4 \times 8}(+12)=2\sqrt{32}(+12)$ <p>or</p> $12\sqrt{2}(+12)-\sqrt{32}=3\sqrt{4^2 \times 2}(+12)-\sqrt{32}=$ $2\sqrt{32}(+12) \text{ oe}$ <p>Note</p> $8\sqrt{2}=2\sqrt{4^2 \times 2} \text{ or } 2\sqrt{16 \times 2} \text{ or } \sqrt{32 \times 4} \text{ or } \sqrt{64 \times 2}$ $12\sqrt{2}=3\sqrt{4^2 \times 2} \text{ or } 3\sqrt{16 \times 2} \text{ or } \sqrt{32 \times 9}$	Shown		A1 dep on M2 for showing working to given answer (they may dismiss the +12 and just deal with the surd part for this stage)
				<b>Total 3 marks</b>



Q20.

Q	Working	Answer	Mark	Notes	
(a)			2	M1	For selecting $10x = 3.2424....$ and $1000x = 324.2424... \text{ oe}$
		show		A1	$\frac{321}{990}$
(b)	e.g. $\frac{4(7 + \sqrt{5})}{49 - 5}$	$\frac{7}{11} + \frac{1}{11}\sqrt{5}$	3	M1 M1 A1	For multiplying the numerator and denominator by $(7 + \sqrt{5})$ For a correct single fraction with brackets expanded in denominator  dep on correct working seen
					<b>Total 5 marks</b>



Q21.

Question	Working	Answer	Mark	Notes	
(a)	$25 + 15\sqrt{2} + 15\sqrt{2} + 9 \times 2$ or $25 + 15\sqrt{2} + 15\sqrt{2} + 18$ or $25 + 30\sqrt{2} + 9 \times 2$ or $25 + 30\sqrt{2} + 18$		2	M1	Expand to give four terms – (must have surds not decimals), at least three correct, or three terms with irrational term and one other correct.  Accept $(\sqrt{2})^2$ for 2
		$43 + 30\sqrt{2}$		A1	dep on M1 awarded
(b)	$\sqrt{8} = 2\sqrt{2}$ or $(q =) \sqrt{8} \times "30\sqrt{2}"$		3	M1	Award M marks independently for simplifying
	$\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{8}} = \frac{\sqrt{8}}{8}$ or $(q =) 30\sqrt{16}$ or $(q =) 60\sqrt{4}$ or $(q =) 30\sqrt{2} \times 2\sqrt{2}$			M1	$\sqrt{8}$ and rationalising the denominator, seen at any points in the solution.
		120		A1	ft from (a) for $30\sqrt{16}$
				A1	ft $4 \times "30"$ from (a)
Total 5 marks					

Q22.

Q	Working	Answer	Mark	Notes	
	$\frac{6}{3-\sqrt{7}} \times \frac{3+\sqrt{7}}{3+\sqrt{7}}$ or $\frac{6}{3-\sqrt{7}} \times \frac{-3-\sqrt{7}}{-3-\sqrt{7}}$			M1	
	$\frac{6(3+\sqrt{7})}{3^2-7}$ or $\frac{6(3+\sqrt{7})}{2}$ or $\frac{6(-3-\sqrt{7})}{-3^2+7}$ or $\frac{6(-3-\sqrt{7})}{-2}$			M1	(numerator may be expanded or denominator may be 4 terms which need to be all correct)
		$9 + 3\sqrt{7}$	3	A1	dep on M2 for $9 + 3\sqrt{7}$ or $3(3 + \sqrt{7})$ from correct working
Total 3 marks					



Q23.

Q	Working	Answer	Mark	Notes
	5025 or 5.025 or 4975 or 4.975		4	B1 Accept 5024.9 for 5025 or 5.0249 for 5.025
	$1.845 \times 10^{-3}$ oe or $1.835 \times 10^{-3}$ oe			B1 Accept $1.8449 \times 10^{-3}$ for $1.845 \times 10^{-3}$
	$\frac{5.025}{1.835 \times 10^{-3}} (= 2738.4...) \text{ oe}$			M1 for correct substitution into $\frac{m_{UB}}{v_{LB}}$ where $5 < m_{UB} \leq 5.025$ and $1.835 \times 10^{-3} \leq v_{LB} < 1.84 \times 10^{-3}$
		2738.4		A1 dep on correct working
				Total 4 marks





Q24.

	47.5 or 52.5 or 1.25 or 1.35		4	B1 for a correct bound, accept 4750 or 5250 or 125 or 135 if working in cm
	eg $\frac{47.5}{1.35} (= 35.18\dots)$ or $\frac{52.5}{1.25} (= 42)$			M1 for correct substitution of $47.5 \leq LB_F < 50$ and $1.3 < UB_{FP} \leq 1.35$ or  $50 < UB_F \leq 52.5$ and $1.25 \leq LB_{FP} < 1.3$
	eg ("42" – "36") $\times$ 8.65 or "42" $\times$ 8.65 – "36" $\times$ 8.65 or 363.3 – 311.4			M1 (dep on M1) for using their lower and upper bounds for the number of fence panels needed to find the cost – lower bound and/or upper bound must be an integer rounded up
	Working required	51.9(0)		A1 cao dep on M2
				<b>Total 4 marks</b>

Q25.

Question	Working	Answer	Mark	Notes
	168.5 – 121.5	47	2	M1 for 168.5 or 168.49 or 168.499... or 121.5 A1 for 47 with no incorrect working
				<b>Total 2 marks</b>

Q26.

Question Number	Working	Answer	Mark	Notes
	1.75 seen		2	M1
		8		A1
				<b>Total 2 marks</b>



Q27.

Q	Working	Answer	Mark	Notes
(a)		1.45	1	B1 allow $1.44\dot{9}$ or 1.44999(9...)
(b)		1.35	1	B1 cao  SCB1 for (a) 1.35 (b) 1.45 [score B0B1]
				Total 2 marks