3 (a) Express $\frac{\sqrt{27^x}}{3^{2x-1}}$ in the form 3^p, where p is an expression in terms of x.

[3 marks]

(b) **Hence** solve the equation $\frac{\sqrt{27^x}}{3^{2x-1}} = \sqrt[3]{81}$.

[2 marks]

1 (a) (i) Express $\sqrt{75}$ in the form $k\sqrt{3}$, where k is an integer.

[1 mark]

(ii) Simplify $\frac{2\sqrt{75} + 3\sqrt{12}}{\sqrt{48}}$.

[3 marks]

(b) Express $\frac{7\sqrt{5} - 10\sqrt{3}}{4\sqrt{5} - 5\sqrt{3}}$ in the form $m - \sqrt{n}$, where m and n are integers.

[4 marks]

2. Express 9^{3x+1} in the form 3^y, giving y in the form $ax + b$, where a and b are constants.

(2)

Q3	Solution	Mark	Total	Comment
(a)	$\sqrt{27^x} = 3^{0.5(3x)}$	B1		Seen or used. eg $\log\sqrt{27^x} = 1.5x\log 3$.
	$\dfrac{\sqrt{27^x}}{3^{2x-1}} = 3^{0.5(3x)-(2x-1)}$	M1		$3^{kx} \div 3^{2x-1}$ OE $= 3^{kx-(2x-1)}$ or $= 3^{kx-2x-1}$ or $p\log 3 = kx\log 3 - (2x-1)\log 3$
	$(= 3^{1-0.5x})$ (OE Accept form $p = \ldots\ldots$)	A1	3	OE 3^p Expression for p need not be simplified. eg $3^{0.5(3x)-(2x-1)}$ NMS 3/3
(b)	$\sqrt[3]{81} = 3^{\frac{4}{3}}$	B1		Seen or used; or $3^{3p} = 3^4$ or $\dfrac{\log 81}{\log 3} = 4$
	$3^{1-0.5x} = 3^{\frac{4}{3}} \Rightarrow x = -\dfrac{2}{3}$	B1	2	OE must be exact and from correct work. NMS scores 0/2
	Total		5	

Q1	Solution	Mark	Total	Comment
(a)(i)	$5\sqrt{3}$	B1	1	
(ii)	$\dfrac{\text{"their"}10\sqrt{3} + \text{"their"}6\sqrt{3}}{\text{"their"}4\sqrt{3}}$	M1		attempt to write each term as $k\sqrt{3}$ with **either** $3\sqrt{12} = 6\sqrt{3}$ **or** $\sqrt{48} = 4\sqrt{3}$
	$\dfrac{10\sqrt{3}+6\sqrt{3}}{4\sqrt{3}}$	A1		
	$= 4$	A1	3	
(b)	$\dfrac{7\sqrt{5}-10\sqrt{3}}{4\sqrt{5}-5\sqrt{3}} \times \dfrac{4\sqrt{5}+5\sqrt{3}}{4\sqrt{5}+5\sqrt{3}}$	M1		
	(Numerator =) $140 - 40\sqrt{3}\sqrt{5} + 35\sqrt{3}\sqrt{5} - 150$	A1		at least this far
	(Denominator = $80 + 20\sqrt{3}\sqrt{5} - 20\sqrt{3}\sqrt{5} - 75$) $= 5$	B1		must be seen as denominator
	Value $= \dfrac{-10-5\sqrt{15}}{5}$			
	$= -2-\sqrt{15}$	A1cso	4	condone $-\sqrt{15}-2$ **No ISW** here
	Total		8	

Question Number	Scheme	Notes	Marks
2	9^{3x+1} = for example $3^{2(3x+1)}$ or $(3^2)^{3x+1}$ or $(3^{(3x+1)})^2$ or $3^{3x+1} \times 3^{3x+1}$ or $(3\times 3)^{3x+1}$ or $3^2 \times (3^2)^{3x}$ or $(9^{\frac{1}{2}})^y$ or $9^{\frac{1}{2}y}$ or $y = 2(3x+1)$	Expresses 9^{3x+1} correctly as a power of 3 or expresses 3^y correctly as a power of 9 or expresses y correctly in terms of x (**This mark is <u>not</u> for just** $3^2 = 9$)	M1
	$= 3^{6x+2}$ or $y = 6x + 2$ or $a = 6$, $b = 2$	Cao (isw if necessary)	A1
	Providing there is no incorrect work, allow sight of $6x + 2$ to score both marks Correct answer only implies both marks **Special case:** 3^{6x+1} **only** scores M1A0		
			[2]

1 (a) Simplify $\sqrt{98}-\sqrt{32}$, giving your answer in the form $k\sqrt{2}$, where k is an integer.

[2 marks]

(b) Hence, or otherwise, express $\dfrac{\sqrt{98}-\sqrt{32}}{2+3\sqrt{2}}$ in the form $p+q\sqrt{2}$, giving the rational numbers p and q in their simplest form.

[4 marks]

1 (a) Express $\dfrac{1+4\sqrt{7}}{5+2\sqrt{7}}$ in the form m + $n\sqrt{7}$, where m and n are integers.

[4 marks]

(b) Solve the equation

$$x\left(9\sqrt{5}-2\sqrt{45}\right)=\sqrt{80}$$

giving your answer in its simplest form.

[3 marks]

Q1	Solution	Mark	Total	Comment
(a)	$\sqrt{98}=7\sqrt{2}$ or $\sqrt{32}=4\sqrt{2}$	M1		
	$\left(7\sqrt{2}-4\sqrt{2}=\right)\ 3\sqrt{2}$	A1	2	
(b)	$\dfrac{**}{2+3\sqrt{2}}\times\dfrac{2-3\sqrt{2}}{2-3\sqrt{2}}$	M1		
	[Numerator =] $6\sqrt{2}-18$	A1		multiplied out
	[Denominator $=4+6\sqrt{2}-6\sqrt{2}-18$] $=-14$	B1		must be seen as denominator
	Value $=\dfrac{6\sqrt{2}-18}{-14}$ $=\dfrac{9}{7}-\dfrac{3}{7}\sqrt{2}$ **or** $-\dfrac{3}{7}\sqrt{2}+\dfrac{9}{7}$	A1cso	4	must have these two simplified fractions for **A1 cso** but may have $1\frac{2}{7}-\frac{3}{7}\sqrt{2}$ **etc** condone $\dfrac{9}{7}-\dfrac{3\sqrt{2}}{7}$ for **A1 cso** No **ISW.**
	Total		6	

Q1	Solution	Mark	Total	Comment
	NO MISREADS ALLOWED IN THIS QUESTION			
(a)	$\dfrac{1+4\sqrt{7}}{5+2\sqrt{7}}\times\dfrac{5-2\sqrt{7}}{5-2\sqrt{7}}$	M1		
	(Numerator =) $5+20\sqrt{7}-2\sqrt{7}-56$	A1		at least this far
	(Denominator = $25+10\sqrt{7}-10\sqrt{7}-28$) $=-3$	B1		must be seen as denominator
	Value $=\dfrac{-51+18\sqrt{7}}{-3}$ $=17-6\sqrt{7}$	A1cso	4	condone $-6\sqrt{7}+17$
(b)	$x\left(9\sqrt{5}-\text{"}their\text{"}6\sqrt{5}\right)=\text{"}their\text{"}4\sqrt{5}$	M1		attempt to write each term as $k\sqrt{5}$ with **either** $2\sqrt{45}=6\sqrt{5}$ **or** $\sqrt{80}=4\sqrt{5}$
	$x\left(9\sqrt{5}-6\sqrt{5}\right)=4\sqrt{5}$	A1		**OE** must have equation
	$x=\dfrac{4}{3}$ or $x=1\frac{1}{3}$ or $x=1.\dot{3}$	A1	3	must be simplified to one of these
	Total		7	

2 (a) Simplify $(3\sqrt{5})^2$.

[1 mark]

(b) Express $\dfrac{(3\sqrt{5})^2+\sqrt{5}}{7+3\sqrt{5}}$ in the form $m+n\sqrt{5}$, where m and n are integers.

[4 marks]

1. (a) Simplify $\left(3\sqrt{7}\right)^2$

(1)

(b) Simplify

$$\frac{\sqrt{3}}{5\sqrt{3}+6\sqrt{2}}$$

giving your answer in the form $a + b\sqrt{c}$, where a, b and c are integers and $b \neq -1$

(4)

Q2	Solution	Mark	Total	Comment
(a)	45	B1	1	
(b)	$\frac{**+\sqrt{5}}{7+3\sqrt{5}} \times \frac{7-3\sqrt{5}}{7-3\sqrt{5}}$	M1		
	(Numerator =) $315+7\sqrt{5}-135\sqrt{5}-15$	A1		at least this far
	(Denominator = $49+21\sqrt{5}-21\sqrt{5}-45$) $=4$	B1		must be seen as denominator
	Value $=\frac{300-128\sqrt{5}}{4}$ $=75-32\sqrt{5}$	A1cso	4	
	Total		5	

Question Number	Scheme	Notes	Marks
1.(a)	$\left(3\sqrt{7}\right)^2 = 63$	Cao	B1
			[1]
(b)	$\frac{\sqrt{3}}{5\sqrt{3}+6\sqrt{2}} \times \frac{5\sqrt{3}-6\sqrt{2}}{5\sqrt{3}-6\sqrt{2}}$	For rationalising the denominator by a correct method (i.e. multiply numerator and denominator by $5\sqrt{3}-6\sqrt{2}$). This statement is sufficient.	M1
	$=\frac{15-6\sqrt{6}}{\ldots}$ **or** $=\frac{\ldots}{75-72}$	For 15 – 6√6 (or $3\times5-6\sqrt{6}$) in the numerator **or** 75 – 72 (or 3 from correct work) in the denominator seen at some point i.e. apply isw	A1 **(M1 on Epen)**
	$=\frac{15-6\sqrt{6}}{\ldots}$ **and** $=\frac{\ldots}{75-72}$	For 15 – 6√6 (or $3\times5-6\sqrt{6}$) in the numerator **and** 75 – 72 (or 3 from correct work) in the denominator seen at some point i.e. apply isw	A1
	$5-2\sqrt{6}$	Fully correct expression. Allow $a = 5$ $b = -2$, $c = 6$ but apply isw e.g. 5 – 2√6 followed by $a = 5$ $b = 2$, $c = 6$	A1
			[4]

1. (i) Simplify

$$\sqrt{48} - \frac{6}{\sqrt{3}}$$

Write your answer in the form $a\sqrt{3}$, where a is an integer to be found.

(2)

(ii) Solve the equation

$$3^{6x-3} = 81$$

Write your answer as a rational number.

(3)

3. (a) Simplify

$$\sqrt{50} - \sqrt{18}$$

giving your answer in the form $a\sqrt{2}$, where a is an integer.

(2)

(b) Hence, or otherwise, simplify

$$\frac{12\sqrt{3}}{\sqrt{50} - \sqrt{18}}$$

giving your answer in the form $b\sqrt{c}$, where b and c are integers and $b \neq 1$

(3)

Question Number	Scheme		Marks
1.(i) Way 1	$\sqrt{48}=\sqrt{16}\sqrt{3}$ or $\frac{6}{\sqrt{3}}=6\frac{\sqrt{3}}{3}$	Writes one of the terms of the given expression correctly in terms of $\sqrt{3}$	M1
	$\Rightarrow \sqrt{48}-\frac{6}{\sqrt{3}}=2\sqrt{3}$	A correct answer of $2\sqrt{3}$. A correct answer with **no** working implies both marks.	A1
			(2)

(ii) Way 1	$81=3^4$ or $\log_3 81=6x-3$	For $81=3^4$ or $\log_3 81=6x-3$. This may be implied by subsequent work.	B1
	$3^{6x-3}=3^4$ or $\log_3 81=6x-3$ $\Rightarrow 4=6x-3 \Rightarrow x=...$	Solves an equation of the form $6x-3=k$ where k is their power of 3.	M1
	$\Rightarrow x=\frac{4+3}{6}=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or 1.16 with a dot over the 6	A1
			(3)

3.(a)	$\sqrt{50}-\sqrt{18}=5\sqrt{2}-3\sqrt{2}$	$\sqrt{50}=5\sqrt{2}$ or $\sqrt{18}=3\sqrt{2}$ **and** the other term in the form $k\sqrt{2}$. This mark may be implied by the correct answer $2\sqrt{2}$	M1
	$=2\sqrt{2}$	Or $a=2$	A1
			[2]
(b) **WAY 1**	$\frac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\frac{12\sqrt{3}}{"2"\sqrt{2}}$	Uses part (a) by replacing denominator by their $a\sqrt{2}$ where a is numeric. This is all that is required for this mark.	M1
	$=\frac{12\sqrt{3}}{"2"\sqrt{2}}\times\frac{\sqrt{2}}{\sqrt{2}}=\frac{12\sqrt{6}}{4}$	Rationalises the denominator by a correct method e.g. multiplies numerator and denominator by $k\sqrt{2}$ to obtain a multiple of $\sqrt{6}$. Note that multiplying numerator and denominator by $2\sqrt{2}$ or $-2\sqrt{2}$ is quite common and is acceptable for this mark. May be implied by a correct answer. **This is dependent on the first M1.**	dM1
	$=3\sqrt{6}$ or $b=3$, $c=6$	Cao and cso	A1
			[3]
(b) WAY 2	$\frac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}\times\frac{\sqrt{50}+\sqrt{18}}{\sqrt{50}+\sqrt{18}}$ **or** $\frac{12\sqrt{3}}{5\sqrt{2}-3\sqrt{2}}\times\frac{5\sqrt{2}+3\sqrt{2}}{5\sqrt{2}+3\sqrt{2}}$	For rationalising the denominator by a correct method i.e. multiplying numerator and denominator by $k\left(\sqrt{50}+\sqrt{18}\right)$	M1
	$\frac{60\sqrt{6}+36\sqrt{6}}{50-18}$	For replacing numerator by $\alpha\sqrt{6}+\beta\sqrt{6}$. **This is dependent on the first M1 and there is no need to consider the denominator for this mark.**	dM1
	$=3\sqrt{6}$ or $b=3$, $c=6$	Cao and cso	A1
			[3]

1. Simplify

(a) $(2\sqrt{5})^2$

(1)

(b) $\dfrac{\sqrt{2}}{2\sqrt{5} - 3\sqrt{2}}$ giving your answer in the form $a + \sqrt{b}$, where a and b are integers.

(4)

1.(a)	20	Sight of 20. (4×5 is not sufficient)	B1
			(1)
(b)	$\frac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}\times\frac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}$	Multiplies top and bottom by a **correct** expression. This statement is sufficient. NB $2\sqrt{5}+3\sqrt{2}\equiv\sqrt{20}+\sqrt{18}$	M1
	(Allow to multiply top and bottom by $k(2\sqrt{5}+3\sqrt{2})$)		
	$=\frac{...}{2}$	Obtains a denominator of 2 or sight of $\left(2\sqrt{5}-3\sqrt{2}\right)\left(2\sqrt{5}+3\sqrt{2}\right)=2$ with no errors seen in this expansion. May be implied by $\frac{...}{2k}$	A1
	Note that M0A1 is not possible. The 2 must come from a correct method.		
	Note that if M1 is scored there is no need to consider the numerator. **e.g.** $\frac{2(MR?)}{2\sqrt{5}-3\sqrt{2}}\times\frac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}=\frac{...}{2}$ scores M1A1		
	Numerator = $\sqrt{2}(2\sqrt{5}\pm3\sqrt{2})=2\sqrt{10}\pm6$	An attempt to multiply the numerator by $\pm\left(2\sqrt{5}\pm3\sqrt{2}\right)$ and obtain an expression of the form $p+q\sqrt{10}$ where p and q are integers. This may be implied by e.g. $2\sqrt{10}+3\sqrt{4}$ or by their final answer.	M1
	(Allow attempt to multiply the numerator by $k(2\sqrt{5}\pm3\sqrt{2})$)		
	$\frac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}=\frac{2\sqrt{10}+6}{2}=3+\sqrt{10}$	Cso. For the answer as written or $\sqrt{10}+3$ or a statement that a = 3 and b = 10. Score when first seen and ignore any subsequent attempt to 'simplify'. Allow $1\sqrt{10}$ for $\sqrt{10}$	A1
			(4)