14 Simplify.

$\sqrt{125} + \sqrt{80}$

$\sqrt{25} \times \sqrt{5} + \sqrt{16} \times \sqrt{5}$

$= 5\sqrt{5} + 4\sqrt{5}$

$= 9\sqrt{5}$

$9\sqrt{5}$ ..... [2]

11 Simplify $\sqrt{27} + \sqrt{12} - \sqrt{108}$.

$\sqrt{9} \times \sqrt{3} + \sqrt{4} \times \sqrt{3} - \sqrt{36} \times \sqrt{3}$

$= 3\sqrt{3} + 2\sqrt{3} - 6\sqrt{3}$

$= 5\sqrt{3} - 6\sqrt{3}$

$= -\sqrt{3}$

$-\sqrt{3}$ ..... [2]

8 Expand and simplify $(2\sqrt{3}-5)(4+\sqrt{3})$.

$8\sqrt{3} + 2\sqrt{9} - 20 - 5\sqrt{3}$

$= 8\sqrt{3} + 2\times3 - 20 - 5\sqrt{3}$

$= 3\sqrt{3} + 6 - 20$

$= 3\sqrt{3} - 14$

$3\sqrt{3} - 14$ [2]

11 Expand and simplify.

$(4+2\sqrt{3})(5-\sqrt{3})$

$20 - 4\sqrt{3} + 10\sqrt{3} - 2\sqrt{9}$

$= 20 + 6\sqrt{3} - 2\times3$

$= 20 + 6\sqrt{3} - 6$

$= 14 + 6\sqrt{3}$

$14 + 6\sqrt{3}$ [2]

13 $(2\sqrt{3}-3\sqrt{2})^2 = p+q\sqrt{6}$

Find the value of p and the value of q.

$(2\sqrt{3} - 3\sqrt{2})(2\sqrt{3} - 3\sqrt{2})$

$= 4\sqrt{9} - 6\sqrt{6} - 6\sqrt{6} + 9\sqrt{4}$

$= 4\times3 - 12\sqrt{6} + 9\times2$

$= 12 - 12\sqrt{6} + 18$

$= 30 - 12\sqrt{6}$

$p =$ 30

$q =$ -12 [3]

15 (a) Expand and simplify.

$(2-\sqrt{5})(1-3\sqrt{5})$

$2 - 6\sqrt{5} - \sqrt{5} + 3\sqrt{25}$

$= 2 - 7\sqrt{5} + 3\times 5$

$= 2 - 7\sqrt{5} + 15$

$= 17 - 7\sqrt{5}$

$17 - 7\sqrt{5}$ [2]

(b) Rationalise the denominator.
Give your answer in its simplest form.

$\frac{6}{\sqrt{10}}$

$\frac{6}{\sqrt{10}} \times \frac{\sqrt{10}}{\sqrt{10}} = \frac{6\sqrt{10}}{10} \div 2$

$= \frac{3\sqrt{10}}{5}$

$\frac{3\sqrt{10}}{5}$ [2]

18 (a) $\frac{9}{\sqrt{3}}$

Rationalise the denominator.
Give your answer in its simplest form.

$\frac{9}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{9\sqrt{3}}{3}$

$= 3\sqrt{3}$

$3\sqrt{3}$ [2]

(b) $(5-\sqrt{2})(1+3\sqrt{2}) = c + k\sqrt{2}$

Find the value of c and the value of k.

$5 + 15\sqrt{2} - \sqrt{2} - 3\sqrt{4}$

$= 5 + 14\sqrt{2} - 3\times 2$

$= 5 + 14\sqrt{2} - 6$

$= -1 + 14\sqrt{2}$

$c =$ -1

$k =$ 14

[2]

15 **(a)** Simplify.

$\sqrt{27} + \sqrt{12}$

$\sqrt{9} \times \sqrt{3} + \sqrt{4} \times \sqrt{3}$

$= 3\sqrt{3} + 2\sqrt{3}$

$= 5\sqrt{3}$

..... $5\sqrt{3}$ ..... [2]

(b) $\frac{40\sqrt{8}}{5\sqrt{2}} = k$, where k is an integer.

Find the value of k.

$\frac{40}{5} \times \frac{\sqrt{8}}{\sqrt{2}} = 8 \times \sqrt{\frac{8}{2}}$

$= 8 \times \sqrt{4}$

$= 8 \times 2$

$= 16$

$k =$ ..... 16 ..... [2]

13 Rationalise the denominator.

$\frac{2}{\sqrt{3}}$

$\frac{2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$

..... $\frac{2\sqrt{3}}{3}$ ..... [1]

20 **(a)** Simplify.

$\sqrt{300} + \sqrt{48}$

$\sqrt{100} \times \sqrt{3} + \sqrt{16} \times \sqrt{3}$

$= 10\sqrt{3} + 4\sqrt{3}$

$= 14\sqrt{3}$

$14\sqrt{3}$ [2]

(b) Rationalise the denominator and simplify.

$\frac{9}{2+\sqrt{7}}$

$\frac{9}{2+\sqrt{7}} \times \frac{(2-\sqrt{7})}{(2-\sqrt{7})} = \frac{9(2-\sqrt{7})}{4 - 2\sqrt{7} + 2\sqrt{7} - \sqrt{49}}$

$= \frac{18 - 9\sqrt{7}}{4 - 7}$

$= \frac{18 - 9\sqrt{7}}{-3}$ $\div 3$ $\div -3$

$= -6 + 3\sqrt{7}$

$-6 + 3\sqrt{7}$ [3]

(c) Rationalise the denominator.

$\frac{1}{3-\sqrt{5}}$

$\frac{1}{3-\sqrt{5}} \times \frac{(3+\sqrt{5})}{(3+\sqrt{5})} = \frac{3+\sqrt{5}}{9 + 3\sqrt{5} - 3\sqrt{5} - \sqrt{25}}$

$= \frac{3+\sqrt{5}}{9-5}$

$= \frac{3+\sqrt{5}}{4}$

$\frac{3+\sqrt{5}}{4}$ [2]

19 **(a)** Simplify.

$\sqrt{32} + \sqrt{98}$

$\sqrt{16} \times \sqrt{2} + \sqrt{49} \times \sqrt{2}$

$= 4\sqrt{2} + 7\sqrt{2}$

$= 11\sqrt{2}$

$11\sqrt{2}$ [2]

(b) Rationalise the denominator.

$\frac{1}{\sqrt{2}+1}$

$\frac{1}{\sqrt{2}+1} \times \frac{(\sqrt{2}-1)}{(\sqrt{2}-1)} = \frac{\sqrt{2}-1}{\sqrt{4}-\sqrt{2}+\sqrt{2}-1}$

$= \frac{\sqrt{2}-1}{2-1}$

$= \frac{\sqrt{2}-1}{1}$

$\sqrt{2}-1$ [2]

13 Rationalise the denominator and simplify.

$\frac{2}{\sqrt{5}+1}$

$\frac{2}{\sqrt{5}+1} \times \frac{(\sqrt{5}-1)}{(\sqrt{5}-1)} = \frac{2(\sqrt{5}-1)}{\sqrt{25}-\sqrt{5}+\sqrt{5}-1}$

$= \frac{2\sqrt{5}-2}{5-1}$

$= \frac{2\sqrt{5}-2}{4}$ ÷2 ÷2

$= \frac{\sqrt{5}-1}{2}$

$\frac{\sqrt{5}-1}{2}$ [3]

13 Rationalise the denominator and simplify.

$\frac{2}{3-\sqrt{5}}$

$\frac{2}{3-\sqrt{5}} \times \frac{(3+\sqrt{5})}{(3+\sqrt{5})} = \frac{2(3+\sqrt{5})}{9-3\sqrt{5}+3\sqrt{5}-\sqrt{25}}$

$= \frac{6+2\sqrt{5}}{9-5}$

$= \frac{6+2\sqrt{5}}{4}$ ÷2 ÷2

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

$\frac{3+\sqrt{5}}{2}$ [3]

7 **(a)** Simplify $\sqrt{98}$.

$\sqrt{49} \times \sqrt{2}$

$= 7\sqrt{2}$

$7\sqrt{2}$ [1]

(b) Rationalise the denominator.

$\frac{3}{\sqrt{5}-2}$

$\frac{3}{\sqrt{5}-2} \times \frac{(\sqrt{5}+2)}{(\sqrt{5}+2)} = \frac{3(\sqrt{5}+2)}{\sqrt{25}+2\sqrt{5}-2\sqrt{5}-4}$

$= \frac{3\sqrt{5}+6}{5-4}$

$= \frac{3\sqrt{5}+6}{1}$

$3\sqrt{5}+6$ [2]

13 **(a)** Simplify fully.

$\sqrt{75} - \sqrt{48} + \sqrt{12}$

$\sqrt{25} \times \sqrt{3} - \sqrt{16} \times \sqrt{3} + \sqrt{4} \times \sqrt{3}$

$= 5\sqrt{3} - 4\sqrt{3} + 2\sqrt{3}$

$= 7\sqrt{3} - 4\sqrt{3}$

$= 3\sqrt{3}$ [2]

(b) Rationalise the denominator, giving your answer in its simplest form.

$\frac{1}{\sqrt{3}+5}$

$\frac{1}{\sqrt{3}+5} \times \frac{(\sqrt{3}-5)}{(\sqrt{3}-5)} = \frac{\sqrt{3}-5}{\sqrt{9}-5\sqrt{3}+5\sqrt{3}-25}$

$= \frac{\sqrt{3}-5}{3-25}$

$= \frac{\sqrt{3}-5}{-22} \times -1 \times -1$

$= \frac{-\sqrt{3}+5}{22}$

$\frac{5-\sqrt{3}}{22}$ [2]

6 (a) Simplify.

$\sqrt{75}-\sqrt{27}$

$\sqrt{25}\times\sqrt{3}-\sqrt{9}\times\sqrt{3}$

$=5\sqrt{3}-3\sqrt{3}$

$=2\sqrt{3}$

$2\sqrt{3}$ [2]

(b) Rationalise the denominator and simplify your answer.

$\frac{10}{5-\sqrt{5}}$

$\frac{10}{5-\sqrt{5}}\times\frac{(5+\sqrt{5})}{(5+\sqrt{5})}=\frac{10(5+\sqrt{5})}{25+5\sqrt{5}-5\sqrt{5}-\sqrt{25}}$

$=\frac{50+10\sqrt{5}}{25-5}$

$=\frac{50+10\sqrt{5}}{20}$ $\div 10$ $\div 10$

$=\frac{5+\sqrt{5}}{2}$

$\frac{5+\sqrt{5}}{2}$ [3]

13 Write in the form $a+b\sqrt{3}$ where a and b are integers.

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

$(5+2\sqrt{3})(5+2\sqrt{3})$

$=25+10\sqrt{3}+10\sqrt{3}+4\sqrt{9}$

$=25+20\sqrt{3}+4\times3$

$=25+20\sqrt{3}+12$

$=37+20\sqrt{3}$

$37+20\sqrt{3}$ [2]

(b) $\frac{5}{2+\sqrt{3}}$

$\frac{5}{2+\sqrt{3}}\times\frac{(2-\sqrt{3})}{(2-\sqrt{3})}=\frac{5(2-\sqrt{3})}{4-2\sqrt{3}+2\sqrt{3}-\sqrt{9}}$

$=\frac{10-5\sqrt{3}}{4-3}$

$=\frac{10-5\sqrt{3}}{1}$

$10-5\sqrt{3}$ [2]

13 Rationalise the denominator.

$$\frac{9}{\sqrt{7}-2}$$

$$\frac{9}{\sqrt{7}-2} \times \frac{(\sqrt{7}+2)}{(\sqrt{7}+2)} = \frac{9(\sqrt{7}+2)}{\sqrt{49}+2\sqrt{7}-2\sqrt{7}-4}$$

$$= \frac{9\sqrt{7}+18}{7-4}$$

$$= \frac{9\sqrt{7}+18}{3} \quad \div 3 \quad \div 3$$

$3\sqrt{7}+6$ [2]

15 Rationalise the denominator.

$$\frac{\sqrt{5}}{\sqrt{5}-1}$$

$$\frac{\sqrt{5}}{\sqrt{5}-1} \times \frac{(\sqrt{5}+1)}{(\sqrt{5}+1)} = \frac{\sqrt{5}(\sqrt{5}+1)}{\sqrt{25}+\sqrt{5}-\sqrt{5}-1}$$

$$= \frac{\sqrt{25}+\sqrt{5}}{5-1}$$

$$= \frac{5+\sqrt{5}}{4}$$

$\frac{5+\sqrt{5}}{4}$ [2]

11 **(a)** Simplify.

$$\sqrt{50}-\sqrt{8}$$

$$\sqrt{25}\times\sqrt{2} - \sqrt{4}\times\sqrt{2}$$

$$5\sqrt{2} - 2\sqrt{2} = 3\sqrt{2}$$

$3\sqrt{2}$ [2]

(b) By rationalising the denominator, simplify

$$\frac{12}{\sqrt{7}-\sqrt{3}}$$

$$\frac{12}{\sqrt{7}-\sqrt{3}} \times \frac{(\sqrt{7}+\sqrt{3})}{(\sqrt{7}+\sqrt{3})} = \frac{12(\sqrt{7}+\sqrt{3})}{\sqrt{49}+\sqrt{21}-\sqrt{21}-\sqrt{9}}$$

$$= \frac{12\sqrt{7}+12\sqrt{3}}{7-3}$$

$$= \frac{12\sqrt{7}+12\sqrt{3}}{4} \quad \div 4 \quad \div 4$$

$3\sqrt{7}+3\sqrt{3}$ [3]

14 Rationalise the denominator. $\frac{5}{\sqrt{3}-\sqrt{2}}$

$$\frac{5}{\sqrt{3}-\sqrt{2}} \times \frac{(\sqrt{3}+\sqrt{2})}{(\sqrt{3}+\sqrt{2})} = \frac{5(\sqrt{3}+\sqrt{2})}{\sqrt{9}+\sqrt{6}-\sqrt{6}-\sqrt{4}}$$

$$= \frac{5\sqrt{3}+5\sqrt{2}}{3-2}$$

$$= \frac{5\sqrt{3}+5\sqrt{2}}{1}$$

$5\sqrt{3}+5\sqrt{2}$ [2]

17 Simplify by rationalising the denominator. $\frac{3}{2\sqrt{2}-1}$

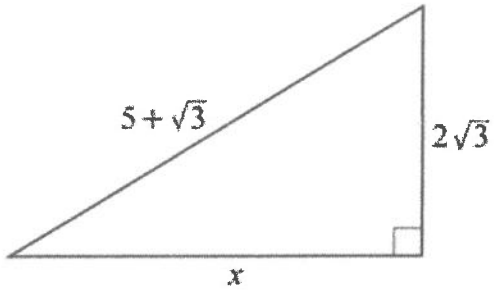
$$\frac{3}{2\sqrt{2}-1} \times \frac{(2\sqrt{2}+1)}{(2\sqrt{2}+1)} = \frac{3(2\sqrt{2}+1)}{4\sqrt{4}+2\sqrt{2}-2\sqrt{2}-1}$$

$$= \frac{6\sqrt{2}+3}{4\times 2-1}$$

$$= \frac{6\sqrt{2}+3}{8-1}$$

$$= \frac{6\sqrt{2}+3}{7}$$

11 In this question all lengths are in centimetres.



NOT TO SCALE

Find the value of x^2.
Give your answer in the form $a+b\sqrt{3}$ where a and b are integers.

Pythagoras:

$x^2 + (2\sqrt{3})^2 = (5+\sqrt{3})^2$

$x^2 + 4\times\sqrt{9} = (5+\sqrt{3})(5+\sqrt{3})$

$x^2 + 4\times 3 = 25 + 5\sqrt{3} + 5\sqrt{3} + \sqrt{9}$

$x^2 + 12 = 25 + 10\sqrt{3} + 3$

$x^2 + 12 = 28 + 10\sqrt{3}$

$-12 \quad -12$

$x^2 = 16 + 10\sqrt{3}$

$x^2 =$ $16 + 10\sqrt{3}$ [4]

4 You are given that $\sqrt{7} = 2.65$ and $\sqrt{70} = 8.37$, each correct to 2 decimal places.

Use this information to find the value of

(a) $\sqrt{700}$, $\sqrt{700} = \sqrt{7}\times\sqrt{100}$

$= \sqrt{7}\times 10$

$= 2.65\times 10 = 26.5$

26.5 [1]

(b) $\sqrt{280}$. $\sqrt{280} = \sqrt{70}\times\sqrt{4}$

$= \sqrt{70}\times 2$

$= 8.37\times 2$

$8.37 \times ,2 = 16.74$

16.74 [1]

17 (a) Expand the brackets and simplify.

$(\sqrt{a}+\sqrt{b})(\sqrt{a}-\sqrt{b})$

$\sqrt{a^2} - \sqrt{ab} + \sqrt{ab} - \sqrt{b^2}$

$= a - b$

$a - b$ [2]

(b) Rationalise the denominator.

$\frac{1}{\sqrt{7}+\sqrt{6}}$

$\frac{1}{\sqrt{7}+\sqrt{6}} \times \frac{(\sqrt{7}-\sqrt{6})}{(\sqrt{7}-\sqrt{6})} = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{49}-\sqrt{42}+\sqrt{42}-\sqrt{36}}$

$= \frac{\sqrt{7}-\sqrt{6}}{7-6}$

$= \frac{\sqrt{7}-\sqrt{6}}{1}$

$\sqrt{7}-\sqrt{6}$ [1]

(c) Work out the value of

$$\frac{1}{\sqrt{9}+\sqrt{8}}+\frac{1}{\sqrt{8}+\sqrt{7}}+\frac{1}{\sqrt{7}+\sqrt{6}}+\frac{1}{\sqrt{6}+\sqrt{5}}+\frac{1}{\sqrt{5}+\sqrt{4}}.$$

using part (b):

$\frac{1}{\sqrt{9}+\sqrt{8}} = \sqrt{9}-\sqrt{8}$ and same for the others.

so expression becomes:

$\sqrt{9} - \sqrt{8} + \sqrt{8} - \sqrt{7} + \sqrt{7} - \sqrt{6} + \sqrt{6} - \sqrt{5} + \sqrt{5} - \sqrt{4}$

$= \sqrt{9} - \sqrt{4}$

$= 3 - 2$

$= 1$

1 [2]