

1. Simplify the following giving your answer in the form a$\sqrt{b}$ where a and b are integers.
   a) $\sqrt{12}$
   b) $\sqrt{20}$
   c) $\sqrt{50}$
   d) $\sqrt{32}$
   e) $\sqrt{108}$
   f) $\sqrt{300}$
   g) $\sqrt{98}$
   h) $\sqrt{192}$

2. Rewrite the following in the form $\boldsymbol{a\sqrt{b}}$, where a and b are integers.
   Simplify your answers where possible.
   a) $\sqrt{2} \times \sqrt{24}$
   b) $\sqrt{3} \times \sqrt{12}$
   c) $\sqrt{3} \times \sqrt{24}$
   d) $\sqrt{2} \times \sqrt{10}$
   e) $\sqrt{40} \times \sqrt{2}$
   f) $\sqrt{3} \times \sqrt{60}$
   g) $\sqrt{7} \times \sqrt{35}$
   h) $\sqrt{50} \times \sqrt{10}$
   i) $\sqrt{8} \times \sqrt{24}$

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3. Calculate the exact values of the following.
   Simplify your answers where possible.
   a) $\sqrt{90} \div \sqrt{10}$
   b) $\sqrt{72} \div \sqrt{2}$
   c) $\sqrt{200} \div \sqrt{8}$
   d) $\sqrt{243} \div \sqrt{3}$
   e) $\sqrt{294} \div \sqrt{6}$
   f) $\sqrt{80} \div \sqrt{10}$
   g) $\sqrt{120} \div \sqrt{10}$
   h) $\sqrt{180} \div \sqrt{3}$
   i) $\sqrt{180} \div \sqrt{9}$
   j) $\sqrt{96} \div \sqrt{6}$
   k) $\sqrt{484} \div \sqrt{22}$
   l) $\sqrt{210} \div \sqrt{35}$

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4. Simplify the following as far as possible.

a) $\sqrt{\frac{1}{9}}$

b) $\sqrt{\frac{4}{25}}$

c) $\sqrt{\frac{49}{121}}$

d) $\sqrt{\frac{100}{64}}$

e) $\sqrt{\frac{18}{200}}$

f) $\sqrt{\frac{2}{25}}$

g) $\sqrt{\frac{108}{147}}$

h) $\sqrt{\frac{27}{64}}$

i) $\sqrt{\frac{98}{121}}$

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5. Simplify the following as far as possible.

a) $2\sqrt{3} + 3\sqrt{3}$

b) $7\sqrt{7} - 3\sqrt{7}$

c) $2\sqrt{3} + 3\sqrt{7}$

d) $2\sqrt{32} + 3\sqrt{2}$

e) $2\sqrt{27} - 3\sqrt{3}$

f) $5\sqrt{7} + 3\sqrt{28}$



6. Simplify the following as far as possible.
   a) $2\sqrt{125} - 3\sqrt{80}$
   b) $\sqrt{108} + 2\sqrt{300}$
   c) $5\sqrt{294} - 3\sqrt{216}$

Warm up

$3 \times \sqrt{5} =$

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

$\sqrt{5} \times \sqrt{5} =$

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

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

Algebraic Identities

$(a+b)^2 = a^2 + 2ab + b^2 = (-a-b)^2$

$(a-b)^2 = a^2 - 2ab + b^2$

$(a-b)(a+b) = a^2 - b^2$

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7. Expand these brackets and simplify where possible.

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

b) $(1+\sqrt{2})(1-\sqrt{2})$

c) $(5-\sqrt{2})^2$

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

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

f) $(7+2\sqrt{2})(7-2\sqrt{2})$

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8. Expand these brackets and simplify where possible.
   a) $(2+\sqrt{6})(4+\sqrt{3})$
   b) $(4-\sqrt{7})(5-\sqrt{2})$
   c) $(1-2\sqrt{10})(6-\sqrt{15})$

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9. Rationalise the denominators of the following fractions. Simplify your answers as far as possible.
   a) $\frac{6}{\sqrt{6}}$
   b) $\frac{8}{\sqrt{8}}$
   c) $\frac{5}{\sqrt{5}}$
   d) $\frac{1}{\sqrt{3}}$
   e) $\frac{15}{\sqrt{5}}$
   f) $\frac{9}{\sqrt{3}}$
   g) $\frac{7}{\sqrt{12}}$
   h) $\frac{12}{\sqrt{1000}}$

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10. Rationalise the denominators of the following fractions. Simplify your answers as far as possible.

a) $\frac{1}{5\sqrt{5}}$

b) $\frac{1}{3\sqrt{3}}$

c) $\frac{3}{4\sqrt{8}}$

d) $\frac{3}{2\sqrt{5}}$

e) $\frac{2}{7\sqrt{3}}$

f) $\frac{1}{6\sqrt{12}}$

g) $\frac{10}{7\sqrt{5}}$

h) $\frac{5}{9\sqrt{10}}$

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Warm up

$(1-\sqrt{5})\,(1+\sqrt{5})$

$(1-2\sqrt{5})\,(1+2\sqrt{5})$

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



11. Rationalise the denominators of the following fractions. Simplify your answers as far as possible.

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

b) $\frac{5}{1-\sqrt{7}}$

c) $\frac{10}{5+\sqrt{11}}$

d) $\frac{9}{12-3\sqrt{17}}$

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12. Rewrite the following as fractions with rational denominators in their simplest form.

a) $\frac{\sqrt{2}}{2+3\sqrt{2}}$

b) $\frac{1+\sqrt{2}}{1-\sqrt{2}}$

c) $\frac{2+\sqrt{3}}{1-\sqrt{3}}$

d) $\frac{1-\sqrt{5}}{2-\sqrt{5}}$

e) $\frac{1+2\sqrt{2}}{1-2\sqrt{2}}$

f) $\frac{7+8\sqrt{2}}{9+5\sqrt{2}}$

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13. Show that $\frac{1}{1-\frac{1}{\sqrt{2}}}$ can be written as $2+\sqrt{2}$.

14. Show that $\frac{1}{1+\frac{1}{\sqrt{3}}}$ can be written as $\frac{3-\sqrt{3}}{2}$.

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15. Find the value of $\sqrt{68} \times \sqrt{153}$.
0580/22/M/J/22 Q4)

16. (a) Simplify. $\sqrt{32} + \sqrt{98}$ [2]
(b) Rationalise the denominator. $\frac{1}{\sqrt{2}+1}$ [2]
0580/02/SP/25 Q19)

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17. Solve using the quadratic formula, giving your answer in simplified surd form:

(a) $x^2 + 10x + 2 = 0$

(b) $x^2 + 6x - 1 = 0$

(c) $x^2 - x - 5 = 0$

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Answers 1 a) $2\sqrt{3}$ b) $2\sqrt{5}$ c) $5\sqrt{2}$ d) $4\sqrt{2}$ e) $6\sqrt{3}$ f) $10\sqrt{3}$ g) $7\sqrt{2}$ h) $8\sqrt{3}$	7 a) $7+4\sqrt{3}$ b) -1 c)$27-10\sqrt{2}$ d) $15-12\sqrt{2}$ e) $18+8\sqrt{3}$ f) 41	15 102
2 a) $4\sqrt{3}$ b) 6 c) $6\sqrt{2}$ d) $2\sqrt{5}$ e) $4\sqrt{5}$ f) $6\sqrt{5}$ g) $7\sqrt{5}$ h) $10\sqrt{5}$ i) $8\sqrt{3}$	8 a) $8+2\sqrt{3}+4\sqrt{6}+3\sqrt{2}$ b) $20-4\sqrt{2}-5\sqrt{7}+\sqrt{14}$ c) $6-\sqrt{15}-12\sqrt{10}+10\sqrt{6}$	16 a) $11\sqrt{2}$ b) $\sqrt{2}-1$
3 a) 3 b) 6 c) 5 d) 9 e) 7 f) $2\sqrt{2}$ g) $2\sqrt{3}$ h) $2\sqrt{15}$ i) $2\sqrt{5}$ j) 4 k) $\sqrt{22}$ l) $\sqrt{6}$	9 a) $\sqrt{6}$ b) $2\sqrt{2}$ c) $\sqrt{5}$ d) $\frac{\sqrt{3}}{3}$ e) $3\sqrt{5}$ f) $3\sqrt{3}$ g) $\frac{7\sqrt{3}}{6}$ h) $=\frac{3\sqrt{10}}{25}$	17 (a) $x=-5\pm\sqrt{23}$ (b) $x=-3\pm\sqrt{10}$ (c) $x=\frac{1\pm\sqrt{21}}{2}$
4 a) $\frac{1}{3}$ b) $\frac{2}{5}$ c) $\frac{7}{11}$ d) $1\frac{1}{4}$ e) $\frac{3}{10}$ f) $\frac{\sqrt{2}}{5}$ g) $\frac{6}{7}$ h) $\frac{3\sqrt{3}}{8}$ i) $\frac{7\sqrt{2}}{11}$	10 a) $\frac{\sqrt{5}}{25}$ b) $\frac{\sqrt{3}}{9}$ c) $\frac{3\sqrt{2}}{\mathbf{16}}$ d) $\frac{3\sqrt{5}}{\mathbf{10}}$ e) $\frac{2\sqrt{3}}{21}$ f) $\frac{\sqrt{3}}{36}$ g) $\frac{2\sqrt{5}}{7}$ h) $\frac{\sqrt{\mathbf{10}}}{\mathbf{18}}$	
5 a) $5\sqrt{3}$ b) $4\sqrt{7}$ c) $2\sqrt{3}+3\sqrt{7}$ d) $11\sqrt{2}$ e) $3\sqrt{3}$ f) $11\sqrt{7}$	11 a) $-\frac{5+5\sqrt{7}}{6}$ b) $\frac{25-5\sqrt{11}}{7}$ c) $\frac{25-5\sqrt{11}}{7}$ (d) $-(12+3\sqrt{17})$	
6 a) $-2\sqrt{5}$ b) $26\sqrt{3}$ c) $17\sqrt{6}$	12 a) $\frac{3-\sqrt{2}}{7}$ b) $-(3+2\sqrt{2})$ c) $-\frac{5+3\sqrt{3}}{2}$ d) $3+\sqrt{5}$ e) $-\frac{9+4\sqrt{2}}{7}$ f) $\frac{37\sqrt{2}-17}{31}$	

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