



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  $a\sqrt{b}$ , 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)  $\sqrt{8} \times \sqrt{24}$



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

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

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

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

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



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)**



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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<b>Answers</b> 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) $\frac{3\sqrt{2}}{16}$ d) $\frac{3\sqrt{5}}{10}$ e) $\frac{2\sqrt{3}}{21}$ f) $\frac{\sqrt{3}}{36}$ g) $\frac{2\sqrt{5}}{7}$ h) $\frac{\sqrt{10}}{18}$	
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) $\frac{37\sqrt{2}-17}{31}$	