9 **a** r^6 **b** $\frac{m^{15}}{n^{12}}$ **c** k^{14}

d $\frac{r^4}{4s^8}$ **e** $\frac{4^4b^{20}}{7^4c^4}$ **f** $\frac{4}{3m^3}$

g $3b$ **h** $\frac{2ab^2}{7^4}$ **i** $\frac{a^{28}}{b^{12}}$

j $\frac{7a^2}{20b^3}$ **k** $\frac{a^{13}b^{17}}{c^{13}}$

10 **a** $2^{20} = (2^4)^5 = (16)^5$
$3^{15} = (3^3)^5 = (27)^5$
$5^{10} = (5^2)^5 = (25)^5$
Ascending order: 2^{20}, 5^{10}, 3^{15}

b $2^{24} = (2^4)^6 = (16)^6$
$3^{18} = (3^3)^6 = (27)^6$
5^6
Ascending order: 5^6, 2^{24}, 3^{18}

c $7^{14} = (7^2)^7 = (49)^7$
$3^{35} = (3^5)^7 = (243)^7$
$2^{56} = (2^8)^7 = (256)^7$
Ascending order: 7^{14}, 3^{35}, 2^{56}

11 Answers will vary. An example is $3(x^3)^4y^3$.

Going further

1 $2^{(2^{(2^2)})} = 2^{(2^{(4)})} = 2^{(16)} = 65\,536$
$\left((2^2)^2\right)^2 = (4^2)^2 = 16^2 = 256$

2 $5^2, 3^{2^2}, 2^{2^{2^2}}, 2^{5^2}, 2^{3^3}, 2^{2^5}$

Extension

Tetrations will vary. All answers equal 1.

Class revision

1 **a** $(b-2)+3 = b+1$ **b** $\frac{(b-2)+3}{2} = \frac{b+1}{2}$

2 B

3 **a** $45abc^2$ **b** $48g^2h^2k$

4 C

5 **a** $2x+6$ **b** $^-2fgh + 2fi$ **c** $3m+9$

6 D

7 A

8 D

9 **a** $A = 2lw$
b Rainfall run-off $(R) = 2alw$
c 126 000 litres

EXERCISE 5A

1 Flow charts keep track of the steps used in an expression and are particularly useful where a lot of steps are involved.

2 **a** $2n+1$ **b** $3\left(\frac{k}{2}+1\right)$

c $\frac{2m-7}{5}$ **d** $\frac{^-c+5}{8}$

e $\frac{3(a-12)}{6}$ **f** $7\left(\frac{s}{2}+1\right)$

3 **a** $\boxed{y} \xrightarrow{+15} \boxed{y+15} \xrightarrow{\div 10} \boxed{\frac{y+15}{10}}$

b $\boxed{r} \xrightarrow{\div 4} \boxed{\frac{r}{4}} \xrightarrow{-1} \boxed{\frac{r}{4}-1} \xrightarrow{\times 2} \boxed{2(\frac{r}{4}-1)}$

c $\boxed{f} \xrightarrow{\div 8} \boxed{\frac{f}{8}} \xrightarrow{-1} \boxed{\frac{f}{8}-1} \xrightarrow{\times 8} \boxed{8(\frac{f}{8}-1)}$

d $\boxed{e} \xrightarrow{\times 11} \boxed{11e} \xrightarrow{-100} \boxed{11e-100} \xrightarrow{\div 3} \boxed{\frac{11e-100}{3}}$

4 **a** Multiply by 2.
b Multiply by 4.
c Multiply by $^-1$.
d Multiply by 2.
e Raise y to a power of 2 or multiply by y.
f Raise k to a power of 3.

5 **a** Divide by 7. **b** Divide by 27.
c Add 7. **d** Multiply by 19.
e Add 7. **f** Divide by 4.

6 **a** $\boxed{x} \xrightarrow{+8} \boxed{x+8} \xrightarrow{\times 2} \boxed{2(x+8)}$

b $\boxed{n} \xrightarrow{-9} \boxed{n-9} \xrightarrow{\times ^-3} \boxed{^-3(n-9)}$

c $\boxed{p} \xrightarrow{\div 5} \boxed{\frac{p}{5}} \xrightarrow{-3} \boxed{\frac{p}{5}-3}$

d $\boxed{t} \xrightarrow{-3} \boxed{t-3} \xrightarrow{\div 5} \boxed{\frac{t-3}{5}}$

e $\boxed{r} \xrightarrow{\times ^-1} \boxed{^-r} \xrightarrow{+18} \boxed{^-r+18}$

f $\boxed{s} \xrightarrow{-15} \boxed{s-15} \xrightarrow{\times 3} \boxed{3(s-15)} \xrightarrow{\div 7} \boxed{\frac{3(s-15)}{7}}$

g $\boxed{w} \xrightarrow{\times 2} \boxed{2w} \xrightarrow{\div 7} \boxed{\frac{2w}{7}} \xrightarrow{-29} \boxed{\frac{2w}{7}-29} \xrightarrow{\times 4} \boxed{4(\frac{2w}{7}-29)}$

h $\boxed{y} \xrightarrow{\times 5} \boxed{5y} \xrightarrow{\div 7} \boxed{\frac{5y}{7}} \xrightarrow{+3} \boxed{\frac{5y}{7}+3} \xrightarrow{\times \frac{1}{2}} \boxed{\frac{1}{2}(\frac{5y}{7}+3)}$

7 **a** 20 **b** $^-3$ **c** 0
d 4 **e** 13 **f** 3
g $^-100$ **h** $\frac{18}{7} = 2\frac{4}{7}$

8 **a** $\boxed{n} \xrightarrow{+5} \boxed{n+5} \xrightarrow{\div 3} \boxed{\frac{n+5}{3}} \xrightarrow{\times 2} \boxed{2(\frac{n+5}{3})}$

b $\boxed{t} \xrightarrow{\div 5} \boxed{\frac{t}{5}} \xrightarrow{-7} \boxed{\frac{t}{5}-7} \xrightarrow{\times \frac{3}{4}} \boxed{\frac{3}{4}(\frac{t}{5}-7)}$

c $\boxed{r} \xrightarrow{\times ^-1} \boxed{^-r} \xrightarrow{+3} \boxed{^-r+3} \xrightarrow{\div 5} \boxed{\frac{^-r+3}{5}}$

d $\boxed{q} \xrightarrow{-7} \boxed{q-7} \xrightarrow{\times 2} \boxed{2(q-7)} \xrightarrow{\times 2(q-7)} \boxed{(2(q-7))^2}$

e $\boxed{w} \xrightarrow{\times 3} \boxed{3w} \xrightarrow{\times 3w} \boxed{9w^2} \xrightarrow{+6} \boxed{9w^2+6}$

9 **a** $\boxed{d} \xrightarrow{+6} \boxed{d+6} \xrightarrow{\div 2} \boxed{\frac{d+6}{2}} \xrightarrow{-2} \boxed{\frac{d+6}{2}-2}$

b $\boxed{c} \xrightarrow{\times 2} \boxed{2c} \xrightarrow{-5} \boxed{2c-5} \xrightarrow{+10} \boxed{2c+5} \xrightarrow{\div 2} \boxed{\frac{2c+5}{2}}$

c $\boxed{n} \xrightarrow{-5} \boxed{n-5} \xrightarrow{\times 2} \boxed{2(n-5)} \xrightarrow{-3} \boxed{2(n-5)-3}$

10 Answers will vary.

Going further

1 $\boxed{w} \xrightarrow{\times -5} \boxed{-5w} \xrightarrow{+18} \boxed{18-5w}$

2 $\boxed{c} \xrightarrow{\times -3} \boxed{-3c} \xrightarrow{+51} \boxed{51-3c} \xrightarrow{\div 7} \boxed{\frac{51-3c}{7}}$

3 $\boxed{b} \xrightarrow{\times -2} \boxed{-2b} \xrightarrow{+3} \boxed{-2b+3} \xrightarrow{\div 5} \boxed{\frac{-2b+3}{5}} \xrightarrow{+9} \boxed{9-\left(\frac{2b+3}{5}\right)}$

Extension

Answers will vary.

EXERCISE 5B

1 Work backwards through the flow chart, starting with the last box; work against the arrows using inverse operations.

2 a To undo a step where you have added, you subtract.
b To undo a step where you have subtracted, you add.
c To undo a step where you have multiplied, you divide.
d To undo a step where you have divided, you multiply.

3 a **i** $2x + 7 = -29$ **ii** $x = -18$
b **i** $2(x + 7) = 32$ **ii** $x = 9$
c **i** $3\left(\frac{k}{3} + 7\right) = -93$ **ii** $k = -114$
d **i** $\frac{2e}{5} + 11 = 17$ **ii** $e = 15$
e **i** $\frac{a+7}{8} + 9 = -4$ **ii** $a = -111$
f **i** $\frac{-2w+8}{3} = -10$ **ii** $w = 19$

4 a $x = -7$ **b** $x = 6$ **c** $m = 9$
d $x = -3$ **e** $x = -17$ **f** $h = 9$
g $k = 27$ **h** $s = 16$ **i** $r = \frac{14}{5}$
j $x = -59$

5 a **i** $x + 42 = 21$
ii $x = -21$. The unknown number is -21.
b **i** $6x = 120$
ii $x = 20$ m. The paddock is 20 m wide.
c **i** $6x = 180°$
ii $x = 30°$. The angles are 30°, 60° and 90°.
d **i** $\frac{5x+7}{3} = 10$
ii $x = \frac{23}{5} = 4.6$. The numbers are 4.6, 6.6 and 18.8.

6 $\boxed{x}_{2.25} \xrightarrow{\times 2} \boxed{2x}_{4.5} \xrightarrow{+5.5} \boxed{2x+5.5}_{10}$ $2x + 5.5 = 10$
$x = 2.25$. One loaf of bread costs $2.25.

7 $\boxed{x}_{11} \xrightarrow{\times 2} \boxed{2x}_{22} \xrightarrow{+3} \boxed{2x+3}_{25}$ $2x + 3 = 25$
$x = 11$. The friends are 11 and 14 years old.

8 $\boxed{x}_{6} \xrightarrow{\times 3} \boxed{3x}_{18} \xrightarrow{+1} \boxed{3x+1}_{19}$ $3x + 1 = 19$
$x = 6$. I ran 6 km yesterday and 13 km today.

9 a Your friend should have added 8 to 20 (under the third box), rather than divide 20 by 2. Therefore, your friend should have written 28 under the second box instead of 10. The correct answer is $x = 14$.
b Your friend should have divided 16 under the third box by 4, rather than subtract 4 from 16. Therefore your friend should have written 4 under the second box instead of 12. The correct answer is $x = 0$.

Going further

1 $x = 2$

2 $x = 20$

Extension

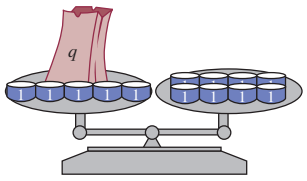
1 $\frac{48}{3x+2} = 6$
Let $3x + 2 = a$
$\frac{48}{a} = 6$
$a = 8$
Therefore:
$3x + 2 = 8$
$x = 2$

2 $7 = \frac{-56}{12-x}$
Let $12 - x = a$
$7 = \frac{-56}{a}$
$a = -8$
Therefore:
$12 - x = -8$
$x = 20$

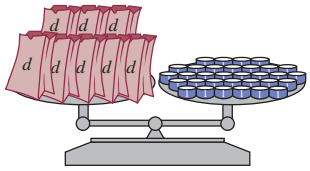
EXERCISE 5C

1 You have to make the same change to the other side.

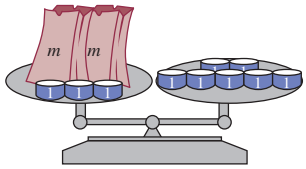
2 a **i** $4r = 12$ **ii** $r = 3$
b **i** $2n + 3 = 7$ **ii** $n = 2$
c **i** $3t + 5 = 8$ **ii** $t = 1$
d **i** $4p + 1 = 13$ **ii** $p = 3$

3 a **i**


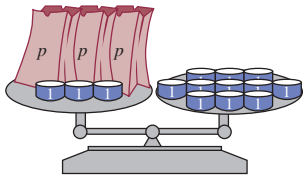
ii $q = 3$

b **i**


ii $d = 3$

c **i**


ii $m = 2$

d **i**


ii $p = 1$