

Mathematics Stage 4

ALGEBRAIC TECHNIQUES

Book 3 Extend and apply the laws and properties
of arithmetic to algebraic terms and expressions

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OVERVIEW

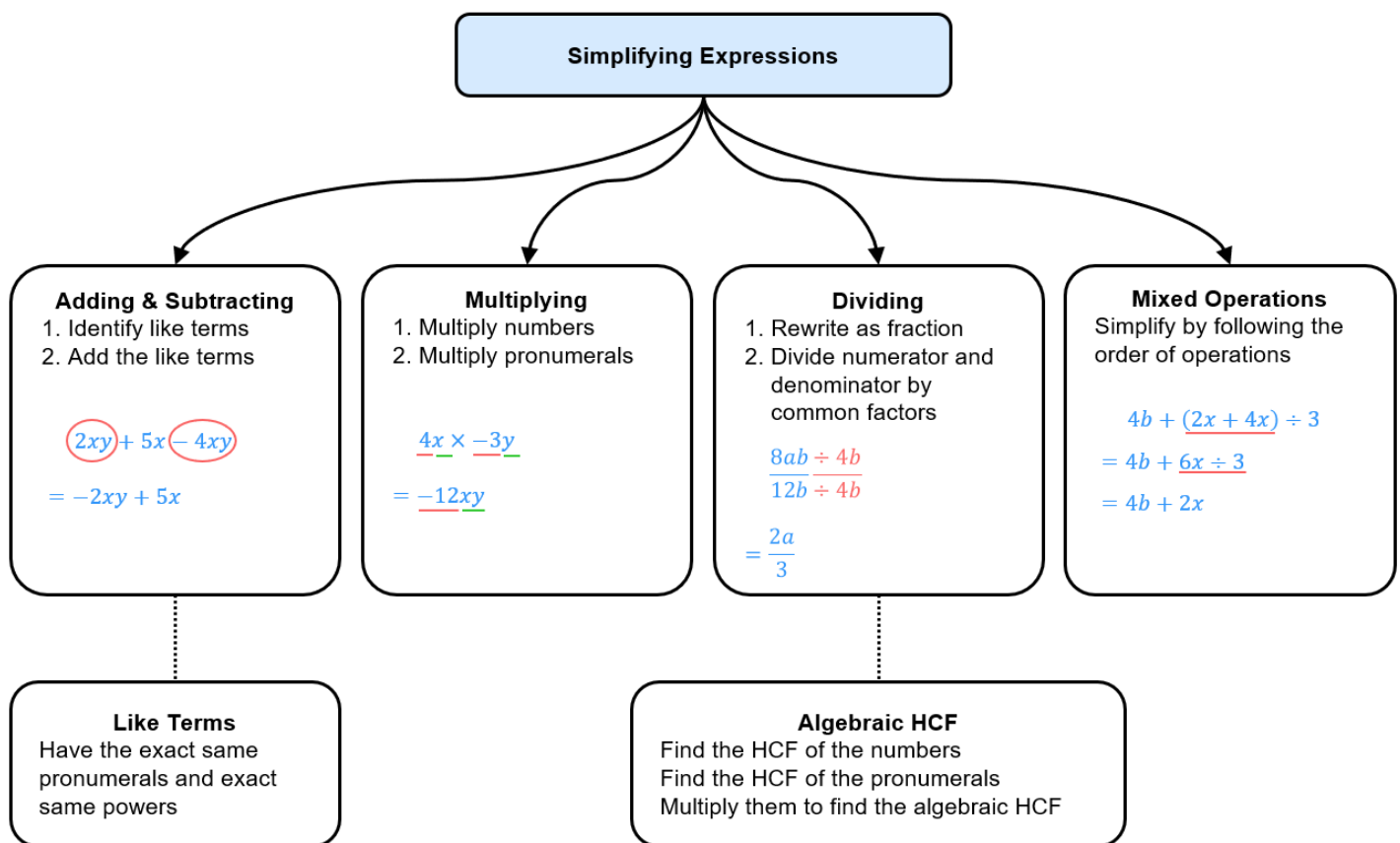
SYLLABUS CONTENT

MA4-ALG-C-01 generalises number properties to operate with algebraic expressions including expansion and factorisation

Extend and apply the laws and properties of arithmetic to algebraic terms and expressions

- Generalise the associative property of addition and multiplication to algebraic expressions
- Generalise the commutative property to algebraic expressions
- Identify like terms, and add and subtract them to simplify algebraic expressions
- Simplify algebraic expressions that involve multiplication and division, including simple algebraic fractions
- Simplify algebraic expressions involving mixed operations

SUMMARY



REVIEW OF PRIOR KNOWLEDGE

1 Write the answers to these calculations

a $24 - 17 + 43$

b $-22 + 6 - 11$

c $4 + 0.2 + 5 + 0.6$

d $3 - 0.4 - 1 + 0.7$

e $0.5 - 1 + 0.3 + 6$

f $4 + \frac{1}{3} + 2 + \frac{1}{3}$

g $12 - \frac{2}{5} + 7 + \frac{6}{5}$

h $\frac{4}{7} - 3 + \frac{2}{7} + 4$

2 Simplify the following:

a $x \times y$

b $a \times a$

c $4 \times x \times y$

d $4 \times z \times y$

e $3 \times 8 \times y$

3 Find the highest common factor of these pairs of numbers.

a 12 and 18

b 15 and 25

c 12 and 20

d 35 and 49

e 45 and 60

f 14 and 28

4 Write the following as fractions.

a $t \div 5$

b $5 \div q$

c $2k \div 5$

d $4k \div 7y$

e $pq \div 8u$

5 Simplify these fractions.

a $\frac{2}{10}$

b $\frac{9}{12}$

c $\frac{24}{12}$

d $\frac{3}{18}$

e $\frac{-15}{5}$

6 Evaluate using the order of operations

a $2 + 3 \times 4 - 1$

b $(6 - 2) \times (5 + 3)$

c $(4 \times 2) - 10 \div 2$

d $3 + 4 \times 2 - 10 \div 2$

e $4 + (6 \times 3) \div 2 - 5$

f $0.5 + 0.3 \times 1.2$

7 Rewrite these operations as addition using the fact:

Adding a negative is the same as subtracting the positive

a $5 - 3$
 $= 5 + (-3)$

b $12 - 6$

c $-2 - 13$

d $82 - 26$

e $82 - 38 + 24$

f $82 - 42 - 78$

8 List the terms in each expression:

Expression	Terms	Expression	Terms
a $4x + 8$		g $11 - 4x - 5y$	
b $4x - 8$		h $11 - 4a - 5b$	
c $4x + 5y - 11$		i $4b^2$	
d $4x - 5y - 11$		j $4b^2 - 7$	
e $4x - 5y + 11$		k $4a^2 - 5b + 11$	
f $-4x - 5y + 11$		l $4a^2 - 5a + 11$	

LIKE TERMS

- Like terms have the **same variables** with the **same powers**.

Example Identify like terms

$3a$	$3a$	Like	Unlike
a	$2a$	Like	Unlike
$-3a$	$2a$	Like	Unlike
$4a$	$4b$	Like	Unlike
$3a$	$3a^2$	Like	Unlike
$2a^2$	$7a^2$	Like	Unlike
$-3a^2$	$7a^2$	Like	Unlike
ay	ya	Like	Unlike
$4ay$	$5ya$	Like	Unlike
$4a^2y$	$5ya^2$	Like	Unlike
$4a^2y$	$5ay^2$	Like	Unlike
5	7	Like	Unlike

Example Identify like terms in an expression.

$\underline{3a} - 5b + \underline{4a}$	Explain what is meant by "like terms"
$\underline{2xy} + 5x - \underline{4yx}$	<i>Like terms have the exact same and the exact same</i>

Identify the like terms in each list.

- | | |
|--------------------------------|-------------------------------------|
| a $7f + 7g - 3f + 3$ | f $14s - 3y - 3x + 14x$ |
| b $3a + 2b + 3k + 10a$ | g $x + 3x - x + x^2$ |
| c $5e + 9e + 10b$ | h $xy + yx - xy + 7xy + 3yz$ |
| d $2pq + 3qp + 9p + 9q$ | i $3j^2k + 2jk^2 + 4j^2k$ |
| e $10n - 7 + 2$ | j $7 + 12x + 2 + 2y$ |
- $7f, -3f$ $-3x, 14x$
 $3a, 10a$ $x, 3x, -x$
 $5e, 9e$ $xy, yx, -3xy, 7xy$
 $2pq, 3qp$ $3j^2k, 4j^2k$
 $-7, 2$ $7, 2$

Key ideas

- Like terms have the same and same

1 Decide whether the terms are like (L) or unlike (U).

a x $2x$ L | U

L

b $2x$ $3x$ L | U

L

c $2x$ $2y$ L | U

U

d $2x$ $2xy$ L | U

U

e xy $2yx$ L | U

L

f xy x^2y L | U

U

g xy^2 y^2x L | U

L

h $5a$ $5b$ L | U

U

i $3b$ $4b$ L | U

L

j 11 12 L | U

L

k $-7d$ $21d$ L | U

L

l e^2 f^2 L | U

U

m 2 $2x$ L | U

U

n $2x$ $2x$ L | U

L

o $2x$ $3y$ L | U

U

p xy yx L | U

L

q x x^2 L | U

U

r xy^2 x^2y L | U

U

s xyz $2yxz$ L | U

L

t 27 $27f$ L | U

U

u $8xy$ $9xy$ L | U

L

v $3z^2$ $3z^3$ L | U

U

w $5a$ $-5a$ L | U

L

x $3x$ x L | U

L

2 In each set of three, circle the term that is **unlike** the other two.

a $2x$ 2 $-2x$

2

b x^2 $3x^2$ $3x$

$3x$

c $3b$ b 3

3

d -3 -10 $-3t$

$-3t$

e $\frac{1}{2}y$ $\frac{1}{2}$ y

$\frac{1}{2}$

f $6ab$ $7ab$ $\frac{a}{b}$

$\frac{a}{b}$

g $3x$ $3y$ $-3x$

$3y$

h $2b$ b^2 $10b$

b^2

3 Circle a set of like terms in each list, **underline** any other sets of like terms.

a $5 - 4a + 2 + 3a$

$5, 2 \mid -4a, 3a$

b $3r - t + 5 + 4r - 2$

$3r, 4r \mid 5, -2$

c $6ab + 4a + 3b - 2ab$

$6ab, -2ab$

d $12t - 3m + 5 + 3m - 9t$

$12t, -9t \mid -3m, 3m$

e $5yx + 3xy - 4 + 3 - 2$

$5yx, 3xy \mid -4, 3, -2$

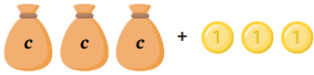
f $4mn + 6nm - 3 + x + 7$

$4mn, 6mn \mid -3, 7$

ADDING AND SUBTRACTING TERMS

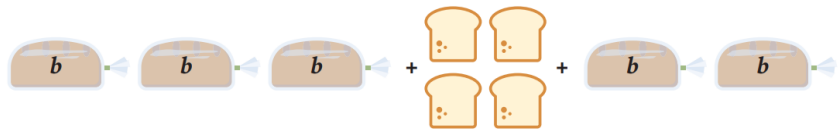
- Simplify expressions by **adding like terms**.
- To simplify expressions with addition and subtraction:
 1. Identify the **like terms**.
 2. Add the like terms.
- An expression with no like terms is fully simplified.

Example Simplify expressions by combining like terms.

1. $2c + 3 + c$ 2. $3c + 3$  	How do you know when an expression is fully simplified? <i>An expression is fully simplified when there are no more</i> Why can't you simplify $3c + 3$ to $6c$? <i>$3c$ and 3 are not, so we cannot add them.</i>
1. $2xy + 5x - 4xy$ 2. $-2xy + 5x$	What are the like terms in this expression? <i>The like terms are and</i> Why does $2xy$ and $-4xy$ simplify to $-2xy$? <i>To simplify, we the like terms.</i>

Simplify these expressions. Identify the like terms and add them.

a $3b + 4 + 2b$



$5b + 4$

b $l + 5 + 4l + 2$



$5l + 7$

c $3x + 6 - 2x$

$x + 6$

d $6 - 7q + 12$

$18 - 7q$

e $5mn + 22 - 8mn$

$-3mn + 22$

f $8xy - 10 + yx + 3$

$9xy - 7$

Key ideas

1. Simplifying means to write an expression that looks neater.
2. We simplify algebraic expressions by the like terms.
3. Remember to treat subtraction as the negative.

1 Simplify the following expressions by collecting like terms.

a $a + a$

$2a$

b $5a + a$

$6a$

c $5a - a$

$4a$

d $5a - 3a$

$2a$

e $5a - 3a + 2$

$2a + 2$

f $5a - 3a + 2 + 3$

$2a + 5$

g $5a + 5a^2$

$5a + 5a^2$

h $5a + 5a^2 + 5$

$5a + 5a^2 + 5$

i $5ab - 3ab$

$2ab$

j $5ab - 3ba + 5$

$2ab + 5$

2 Simplify the following expressions.

a $a + a + a + a$

$4a$

b $a + b + a + a$

$3a + b$

c $a + b + a + b$

$2a + 2b$

d $a + b + a - b$

$2a$

e $a + b - a - b$

0

f $a - b - a - b$

$-2b$

g $6a - b - a - b$

$5a - 2b$

h $6a + b - a - b$

$5a$

i $6a + 5b - a - b$

$5a + 4b$

j $6a + 5b - 4a - b$

$2a + 4b$

k $6a + 5b - 4a - 3b$

$2a + 2b$

l $6a - 5b - 4a - 3b$

$2a - 8b$

m $6a - 5b - 4a + 3b$

$2a - 2b$

n $6a - 5b + 4a + 3b$

$10a - 2b$

o $-6a - 5b + 4a + 3b$

$-2a - 2b$

p $-6a - 5b - 4a + 3b$

$-10a - 2b$

q $-6a - 5b - 4a - 3b$

$-10a - 8b$

r $-6a - 5 - 4a - 3$

$-10a - 8$

s $-6ab - 5 - 4ab - 3$

$-10ab - 8$

t $-5 - 6ab - 3 - 4ab$

$-8 - 10ab$

3 Simplify the following expressions.

a $6j + 5k + 4j + 3k$

$10j + 8k$

b $6j + 5k + 4j - 3k$

$10j + 2k$

c $6j - 5k - 4j - 3k$

$2j - 8k$

d $6j - 5k - 4k - 3k$

$6k - 12k$

f $6j - 5k - 4j + 3k$

$2j - 2k$

g $6j - 5k + 4j + 3k$

$10j - 2k$

h $-6j - 5k + 4j + 3k$

$-2j - 2k$

i $-6j - 5k - 4j - 3k$

$-10j - 8k$

4 Circle the correct option or options in each question. Underline the simplest expression.

a $3x + 2x$ is equivalent to:

$2x + 3x$

$5x$

$6x$

$5xx$

$5x^2$

$2x + 3x \mid \underline{5x}$

b $3x + x$ is equivalent to:

$x + 3x$

$5x$

$4x$

$3xx$

$3x^2$

$x + 3x \mid \underline{4x}$

c $3x - x$ is equivalent to:

$x - 3x$

3

$2x$

$x + x$

$4x - 2x$

$\underline{2x} \mid x + x$

d $3x - 3x$ is equivalent to:

x

$0x$

0

1

$4x - 4x$

$0x \mid \underline{0} \mid 4x - 4x$

e $6x - 5x$ is equivalent to:

$5x - 6x$

$-5x + 6x$

$1x$

1

x

$-5x + 6x \mid 1x \mid \underline{x}$

f $x + x$ is equivalent to:

$x + 1$

$2x$

xx

$x - x$

x^2

$\underline{2x}$

g $x - x$ is equivalent to:

$x + x$

$0x$

0

x

1

$0x \mid \underline{0}$

h $4x - 5x$ is equivalent to:

$5x - 4x$

$x - 1x$

$-1x$

1

$-x$

$-1x \mid \underline{-x}$

5 Simplify the following expressions by collecting like terms.

a $7 + 10 - 5m$	b $3a + 6 + 5a$	c $4 + 2n - n$
$17 - 5m$	$8a + 6$	$n + 4$
d $6 - 7q + 12$	e $9 - 5k + 4$	f $3f + 12 + 8f$
$18 - 7q$	$13 - 5k$	$11f + 12$
g $13w - 6 - 4w$	h $xy - 5 + 2yx$	i $p + 3p - 9$
$9w - 6$	$3xy - 5$	$4p - 9$
j $6t + 4 - 5t$	k $d^2 + 5d - 3d^2$	l $11mn - 2m + 4nm$
$t + 4$	$-2d^2 + 5d$	$15m - 2m$

6 Simplify the following expressions by collecting like terms.

a $4a - 4 + 5b + b$	b $x + 7x + 3y - 4x + y$
$6b + 4a - 4$	$4x + 4y$
c $3x + 7x + 3y - 4x + y$	d $10a + 3 + 4b - 2a$
$6x + 4y$	$8a + 3 + 4b$
e $11a + 4 - 3a + 9$	f $7ab + 4 + 2ab$
$8a + 13$	$9ab + 4$
g $9xy + 2x - 3xy + 3x$	h $7a^2 + 32a - ab + 4a^2$
$6xy + 5x$	$11a^2 + 32a - ab$

7 Read the examples carefully and answer the questions.

Ramon's work:

$$12x + 2 - 5$$

$$12x + 2 - 5$$

$$12x - 3$$


Why didn't Ramon combine the $12x$ with the 2 or -5 ?

They are not terms. 2 and -5 do not have an

Simplify: $3x + 4 - 2$

$3x + 2$

Helaina's work:

$$5 - 4x + 2$$

$$5 - 4x + 2$$

$$4x - 5 + 2$$


What did Helaina do wrong in her first step?

She didn't move the with the term.

Would it have been okay to write $5 + 2 - 4x$?
Explain why or why not.

....., because the follows the terms.

Simplify: $12x + 4 - 5x$

$7x + 4$

Joseph's work:

$$5 - 4x + 12x$$

$$5 - (4x + 12x)$$

$$5 - 16x$$


In the step marked with an arrow, what did Joseph do wrong when choosing the terms to combine?

He forgot to include the with the $4x$.

If Joseph had combined like terms correctly, what should he have gotten as the answer in simplest form?

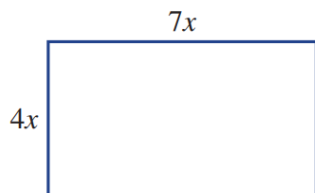
Simplify: $x - 12 + 5$

$5 + 8x$

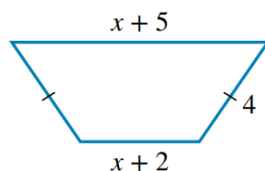
$x - 7$

8 Write simplified expressions for the perimeters of the following shapes.

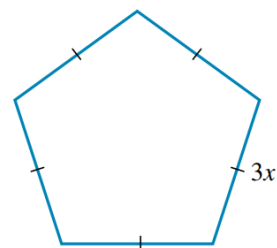
a



b



c

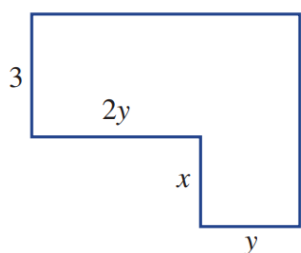


22x

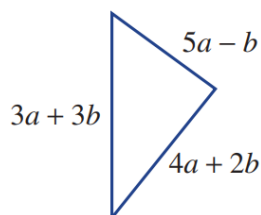
2x + 15

15x

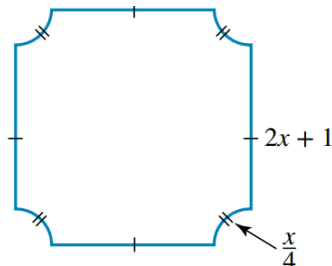
d



e



f



6 + 6y + 2x

12a + 4b

9x + 4

9 Read the example carefully and answer the questions.

Monica's work:

$$3x + 2 - 5x - 20x^2$$

$$3x + 2 - 5x - 20x^2$$

$$2 + 3x - 5x - 20x^2$$

$$2 - 2x - 20x^2$$



Why didn't Monica combine $-2x$ and $-20x^2$?

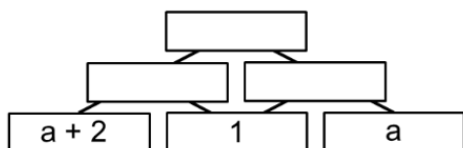
Because they are not terms, they must have the same and the same for us to combine them.

Simplify: $3x + 4 - 6x^2 - 9$

$-5 + 3x - 6x^2$

- 10 Complete each pyramid. Each expression is the sum of the two expressions below it.

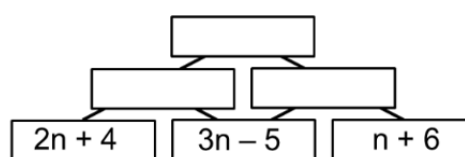
a



$$2a + 4$$

$$a + 3, a + 1$$

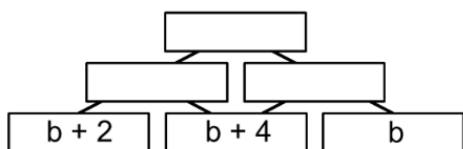
b



$$9n$$

$$5n - 1, 4n + 1$$

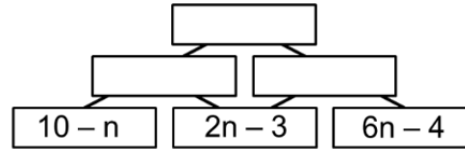
c



$$4b + 10$$

$$2b + 6, 2b + 4$$

d



$$9n$$

$$n + 7, 8n - 7$$

- 11 The length of the line segment shown could be expressed as $a + a + 3 + a + 1$.



- a Write the length in simplest form.

$$3a + 4$$

- b What is the length of the segment if a is equal to 5?

$$19$$

- 12 Let x represent the number of table tennis balls in a bag.

Asher bought 4 bags and Malachi bought 7 bags.

Write simplified expressions for the number of:

- a Table tennis balls Asher has.

$$4x$$

- b Table tennis balls Malachi has.

$$7x$$

- c Table tennis balls that Asher and Malachi have.

$$11x$$

- d Extra table tennis balls that Malachi has compared to Asher

$$3x$$

- 13 Simplify the following:

- a $15l + 2 - 3l + 7c - 12c + 6$

$$8 + 12l - 5c$$

- b $7e + e^2 + 3 - e^2 - 5e + 6 + 6a$

$$2e + 9 + 6a$$

- c $ac + 2pa - 6a + 7 - 5ap + 9ac + 12$

$$10ac - 3ap + 19 - 6a$$

14 Towels cost \$ c each at a shop.

a John buys three towels, Mary buys six towels and Naomi buys four towels.
Write a fully simplified expression for the total amount spent on towels.

13c

b On another occasion, Chris buys n towels.
David buys twice as many as Chris and Edward buys three times as many as David.
Write a simplified expression for the total amount they spent on towels.

9nc

15 Find the missing numbers to make these equations true.

a $10x + 6y - \square x + \square y = 3x + 8y$

7, 2

b $5a - 7b + \square a + \square b = 11a$

6, 7

c $\square c + \square d + \square = 4c + 2d + 1 + 3c + 7d + 4$

7, 9, 5

d $\square a^2b + \square b^2a + 2a^2b + b^2a = 7b^2a + 10a^2b$

8, 6

16 Add the missing expressions to the puzzle to make all six equations true.

$\boxed{5x}$	+	$\boxed{}$	=	$\boxed{7x}$
+		+		+
$\boxed{y}$	+	$\boxed{}$	=	$\boxed{}$
=		=		=
$\boxed{}$	+	$\boxed{}$	=	$\boxed{7x + 3y}$

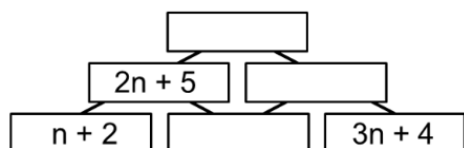
2x

2y, 3y

5x + y, 2x + 2y

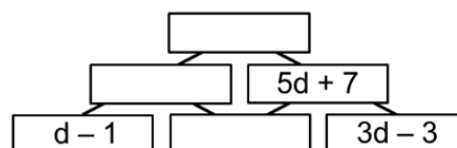
17 Complete each pyramid. Each expression is the sum of the two expressions below it.

a



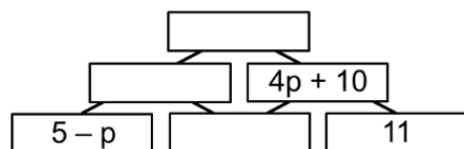
$$\begin{aligned} 6n + 12 \\ 4n + 7 \\ n + 3 \end{aligned}$$

b



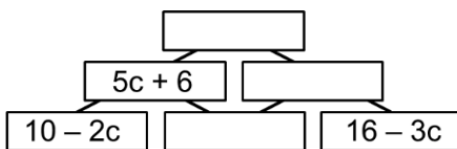
$$\begin{aligned} 8d + 16 \\ 3d + 9 \\ 2d + 10 \end{aligned}$$

c



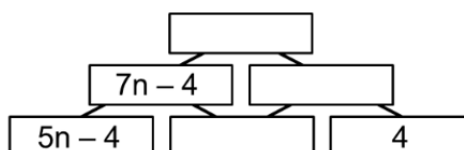
$$\begin{aligned} 7p + 14 \\ 3p + 4 \\ 4p - 1 \end{aligned}$$

d



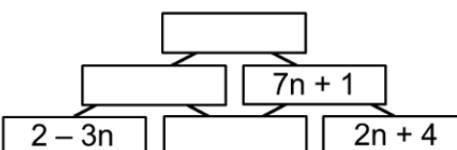
$$\begin{aligned} 9c + 2b \\ 4c + 20 \\ 7c + 4 \end{aligned}$$

e



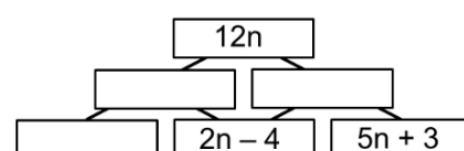
$$\begin{aligned} 9n \\ 2n + 4 \\ 2n \end{aligned}$$

f



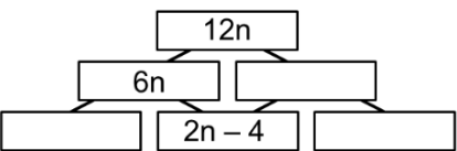
$$\begin{aligned} 9n + 6 \\ 2n + 5 \\ 5n + 3 \end{aligned}$$

g



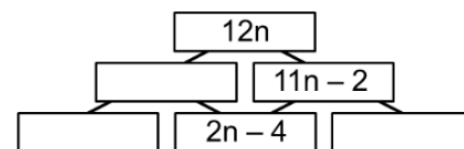
$$\begin{aligned} 5n + 1, 7n - 1 \\ 3n + 5 \end{aligned}$$

h



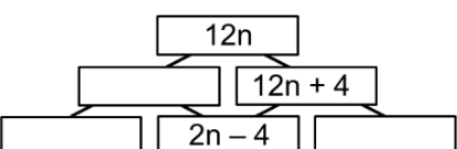
$$\begin{aligned} 6n \\ 4n + 4, 4n + 4 \end{aligned}$$

i



$$\begin{aligned} n + 2 \\ n + 6, 9n + 2 \end{aligned}$$

j



$$\begin{aligned} -4 \\ -2n, 10n + 8 \end{aligned}$$

18 Fill in the missing expressions to make all eight equations true.

$$\boxed{5a} + \boxed{} + \boxed{4a} = \boxed{10a + 3}$$

+ + + +

$$\boxed{2b} + \boxed{4 + a} + \boxed{} = \boxed{}$$

+ + + +

$$\boxed{} + \boxed{} + \boxed{-3a} = \boxed{1}$$

= = = =

$$\boxed{} + \boxed{3a + 8} + \boxed{} = \boxed{10a + 2b + 8}$$

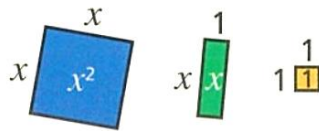
$$\begin{aligned} a + 3 \\ -a, 2b + 4 \\ 2a, a + 1 \\ 7a + 2b, 0 \end{aligned}$$

FURTHER ADDING AND SUBTRACTING TERMS

- Like terms have the same variables with the same powers.

FOUNDATION

- 1 The area of each tile is shown.



Write an expression for the value of these tiles:



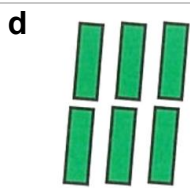
6



4



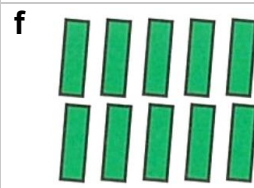
10



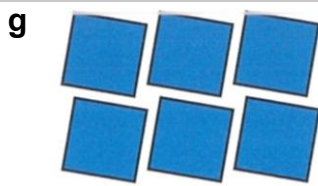
6x



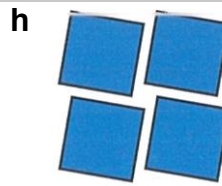
4x



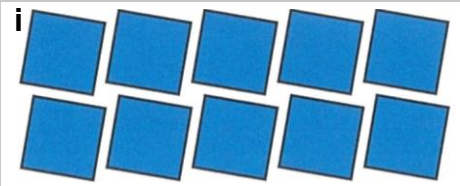
10x



6x²



4x²



10x²

- 2 Simplify each expression.

a $x^2 + x^2 + x^2$

3x²

b $2x^2 + x^2 + x^2$

4x²

c $2x^2 + x^2 - x^2$

2x²

d $8x^2 + 5x^2 - 3x^2$

10x²

e $y^2 + 4y^2 - 3y^2$

2x²

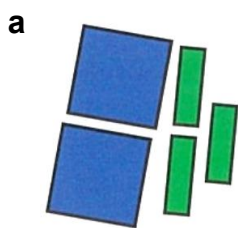
f $5p^2 - 2p^2 + 4p^2$

7p²

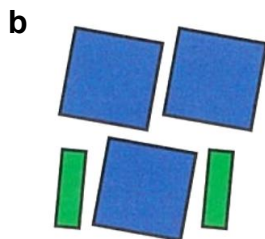
- 3 Zach writes $5x^2 + 5x + 3x^2 = 13x^2$. Explain why Zach is incorrect. Draw a diagram if necessary.

5x is not a like term as it has different power.

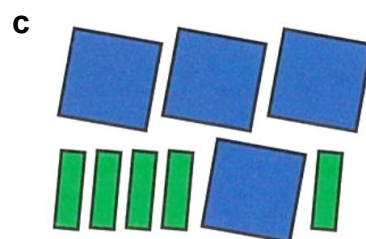
4 Write an expression for the total area.



$$2x^2 + 3x$$

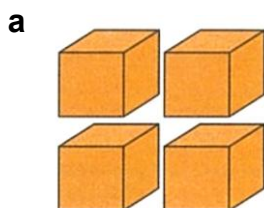


$$3x^2 + 2x$$

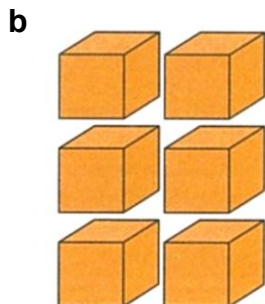


$$4x^2 + 5x$$

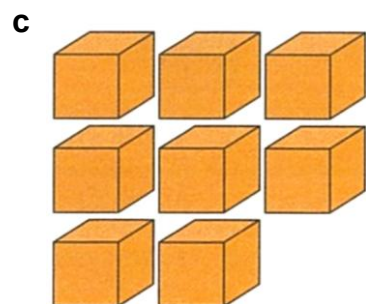
5 The volume of each cube is x^3 . Write an expression for each total volume.



$$4x^3$$



$$6x^3$$



$$8x^3$$

6 Simplify each expression.

a $5x^3 + 9x^3$

$$14x^3$$

b $7y^3 - 4y^3$

$$3y^3$$

c $10p^3 - 2p^3 - 3p^3$

$$5p^3$$

d $27x^3 - 26x^3$

$$x^3$$

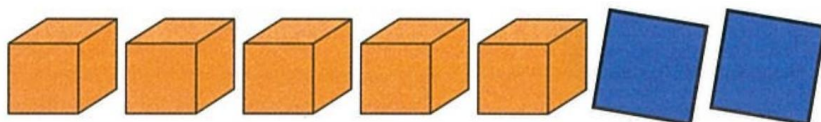
e $11y^3 + 2y^3 - y^3$

$$12y^3$$

f $16t^3 + 15t^3 - 7t^3$

$$24t^3$$

7 Explain how the diagram shows that $5x^3 + 2x^2$ cannot be simplified.



Cubes and squares are not like terms, so we cannot combine them.

8 Simplify each expression.

a $12y^3 + 2x^2 - 5y^3$

b $5x^2 - 9x^2 + 4x^3$

c $8x^3 + 2x^2 - 7x$

d $x^3 + 6x^2 - 2x^3$

e $4m^3 + 12m^2 - 11m^2$

f $21h^3 + 21h^2 - h^3$

$7y^3 + 2x^2$

$-4x^2 + 4x^3$

$8x^3 + 2x^2 - 7x$

$-x^3 + 6x^2$

$4m^3 + m^2$

$20h^3 + 21h^2$

9 Simplify the following.

a $a^2 + b^2 + a^2 + b^2$

k $6a^2 - 5ab - 4a^2 - 3ba$

$2a^2 + 2b^2$

$2a^2 - 8ab$

b $6a^2 + b^2 + a^2 + b^2$

l $6a^2 - 5a^2b - 4a^2 - 3a^2b$

$7a^2 + 2b^2$

$2a^2 - 8a^2b$

c $6a^2 + 5b^2 + a^2 + b^2$

m $6a^2 - 5a^2b - 4a^2 + 3a^2b$

$7a^2 + 6b^2$

$2a^2 - 2a^2b$

d $6a^2 + 5b^2 + 4a^2 + b^2$

n $6a^2 - 5a^2b - 4a^2 + 3ab^2$

$10a^2 + 6b^2$

$2a^2 - 5a^2b + 3ab^2$

e $6a^2 + 5b^2 + 4a^2 + 3b^2$

o $6a^2 - 5ab^2 - 4a^2 + 3ab^2$

$10a^2 + 8b^2$

$2a^2 - 2ab^2$

f $6a^2 + 5b^2 - 4a^2 + 3b^2$

p $-6a^2 - 5ab^2 - 4a^2 + 3ab^2$

$2a^2 + 8b^2$

$-10a^2 - 2ab^2$

g $6a^2 + 5b^2 - 4a^2 - 3b^2$

q $-6 - 5ab^2 - 4 + 3ab^2$

$2a^2 + 2b^2$

$-10 - 2ab^2$

h $6a^2 - 5b^2 - 4a^2 - 3b^2$

r $-6a - 5ab^2 - 4a + 3ab^2$

$2a^2 - 8b^2$

$-10a - 2ab^2$

i $6a^2 - 5b - 4a^2 - 3b$

s $-6ab - 5ab^2 - 4ab + 3ab^2$

$2a^2 - 8b$

$-10ab - 2ab^2$

j $6a^2 - 5ab - 4a^2 - 3ab$

t $-6a^2b - 5ab^2 - 4a^2b + 3ab^2$

$2a^2 - 8ab$

$-10a^2b - 2ab^2$

MULTIPLYING TERMS

- Algebraic expressions don't use multiplication signs $\times$
- To simplify expressions involving multiplication:
 - Multiply the numbers.
 - Multiply the pronumerals.

Example Simplify expressions involving multiplication.

$\begin{array}{c} \underline{2} \times \underline{3} \times \underline{x} \\ = \underline{6x} \end{array}$	$\begin{array}{c} \underline{4x} \times \underline{-3y} \\ = \underline{-12xy} \end{array}$	$\begin{array}{c} \underline{2x} \times \underline{5x} \\ = \underline{10x^2} \end{array}$
--	---	--

Simplify these expressions.

a	$\underline{2} \times \underline{4} \times \underline{x}$	b	$\underline{3} \times \underline{x} \times \underline{4} \times \underline{y}$	c	$3x \times 5y$	d	$4z \times 7w$
	$8x$		$12xy$		$15xy$		$28zw$
e	$-x \times 9n$	f	$2y \times 5y$	g	$3ab \times a$	h	$3ab \times 8bc$
	$-9xn$		$10y^2$		$3a^2b$		$24ab^2c$

Key ideas

- To multiply two terms, we multiply the and multiply the
- A fully simplified expression should not have any symbols.

1 Simplify these expressions.

a $2 \times x$

b $3 \times 2 \times a$

c $8 \times a \times b$

$2x$

$6a$

$8ab$

d $5 \times 2 \times a \times b$

e $2 \times b \times 5$

f $5 \times a \times 4 \times b$

$10ab$

$10b$

$20ab$

g $x \times 7 \times z \times 4$

h $2 \times a \times 3 \times b \times 6$

i $2 \times a \times a \times y \times 3$

$28xz$

$36ab$

$6a^2y$

2 Simplify these expressions.

a $3a \times 12$

b $7d \times 9$

c $4a \times 3b$

$36a$

$63d$

$12ab$

d $7e \times 9g$

e $8a \times bc$

f $4d \times 7af$

$63eg$

$8abc$

$28adf$

g $a \times 3b \times 4c$

h $2a \times 4b \times c$

i $-3a \times 2g$

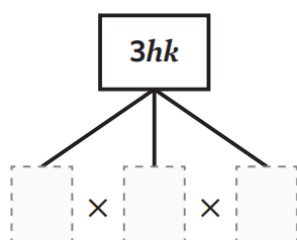
$12abc$

$8abc$

$-6ag$

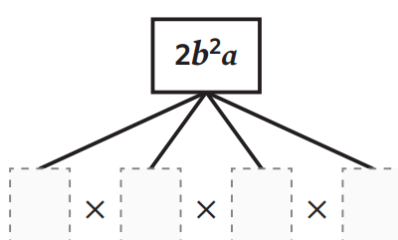
3 Identify the factors of these terms.

a



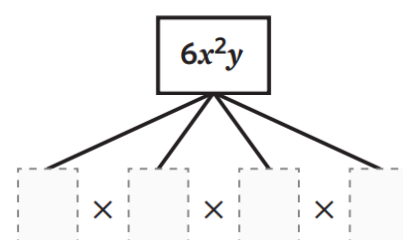
$3, h, k$

b



$2, b, b, a$

c



$6, x, x, y$

4 Simplify these expressions.

a $w \times w$

b $a^2 \times a$

c $3d \times d$

w^2

a^3

$3d^2$

d $2k \times k^2$

e $p \times 7p$

f $q \times 3q^2$

$2k^3$

$7p^2$

$3q^3$

g $6x \times 2x$

h $3z \times 5z^3$

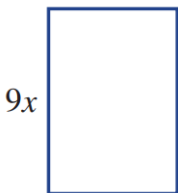
i $-3x \times 9x \times 2xy$

$12x^2$

$15z^4$

$-54x^3y$

- 5 Write a simplified expression for the area of the following rectangles.
Recall that Area = length $\times$ breadth

a  $3k$	b  $6x$	c  $12xy$
d  $8ab$	e  $24x^2$	f  $18xy$

- 6 Simplify these expressions.

a $8ab \times c$	b $7x \times 2y \times x$	c $5d \times 2d \times e$
$8abc$	$14x^2y$	$10d^2e$
d $4xy \times 2xz$	e $5xy \times 2x$	f $9ab \times 2a^2$
$8x^2yz$	$10x^2y$	$18a^3b$
g $4abc \times 2abd$	h $-5xy \times 2yz$	i $-3xz \times (-2z)$
$8a^2b^2cd$	$-10xy^2z$	$6xz^2$

- 7 A farmer has x pigs and y chickens.

- a** Write an expression for the total number of heads.

$x + y$

- b** Write an expression for the total number of legs.

$4x + 2y$

- 8 The weight of a single muesli bar is x grams
- a What is the weight of 4 bars? Write an expression.

$4x$

- b If Jamila buys n bars, what is the total weight of her purchase?

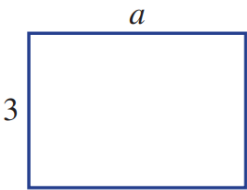
nx

- c Jamila's cousin Roland buys twice as many bars as Jamila.
What is the total weight of Roland's purchase?

$2nx$

- 9 The area of the rectangle shown is $3a$.
The length and breadth of this rectangle are now doubled.

- a Label the new rectangle, showing its dimensions.



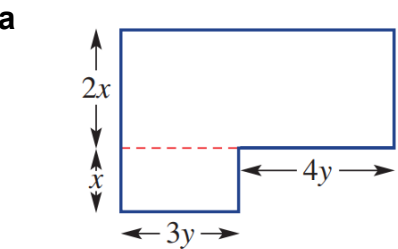
- b How much larger is the area of the new rectangle, compared to the old rectangle?
Show your reasoning.

4 times as large

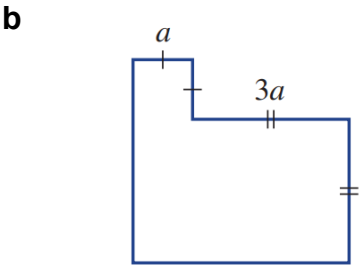
- c How much larger would the new rectangle be if the lengths were tripled?

9 times as large

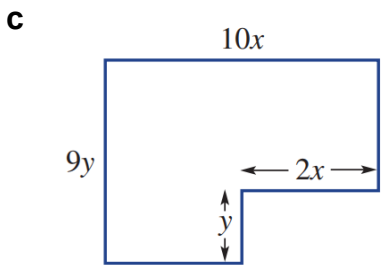
- 10 Write a simplified expression for the area of the following composite shapes.



$17xy$



$13a^2$



$88xy$

FACTORS OF TERMS: NUMERICAL HCF

- A **factor** is a number that **divides evenly** into another term.
- The **highest common factor** is largest factor shared by two terms.

Example Identify the numerical HCF.

Identify the highest common factor of: 2 and $4x$ HCF is 2 $6n$ and 9 HCF is 3 $6y$ and 18 HCF is 6	What is a factor? <i>A factor can into a term with no</i> In the third example, why is the HCF not 3? <i>3 is not the common factor.</i> <i>$6y$ and 18 can both be divided by</i>
--	--

Identify the highest common factor of:

a	20 and 35	b	15 and $10x$	c	$20a$ and $12b$	d	$27a$ and 9
	5		5		4		9
e	$12x$ and -9	f	12 and $8y$	g	$-36y$ and $9x$	h	15 and $30z$
	3		4		9		15

Key ideas

1. The highest common factor is the number that can evenly into two terms.

FOUNDATION

1 Find the highest common factor of the following pairs of terms.

a	$20x$ and 15	b	$10x$ and 15	c	$5x$ and 15
	5		5		5
d	15 and $10x$	e	$20a$ and $12b$	f	$27a$ and $9b$
	5		4		9
g	$7y$ and $14x$	h	$-2y$ and $4x$	i	$11y$ and $-33x$
	7		2		11
j	$8q$ and $-4r$	k	$-3a$ and 6	l	$15p$ and $25q$
	4		3		5

DIVIDING TERMS: NUMERICAL HCF

- Algebraic expressions don't use division signs $\div$
- To simplify expressions involving division:
 - Rewrite any divisions as **fractions**.
 - Divide the numerator and denominator by **common factors**.
Also known as "cancelling."

Example Simplify expressions involving division (numerical HCF).

$20p \div 15$ $= \frac{20p \div 5}{15 \div 5}$ $= \frac{4p}{3}$	How did we know to divide the numerator and denominator by 5? 5 is a of 20p and 15
$18y \div 3x$ $= \frac{18y \div 3}{3x \div 3}$ $= \frac{6y}{x}$	How is this similar to simplifying fractions? We simplify fractions by the numerator and denominator by a common

Simplify these expressions.

a $15x \div 6$ $= \frac{15x \div 3}{6 \div 3}$ $=$ $\frac{5x}{2}$	b $15x \div 5$ $=$ $3x$	c $24 \div 6p$ $=$ $\frac{4}{p}$	d $35 \div 70x$ $=$ $\frac{1}{2x}$
e $\frac{-2x}{6}$ $=$ $-\frac{x}{3}$	f $\frac{15a}{5b}$ $=$ $\frac{3a}{b}$	g $\frac{3a}{6x}$ $=$ $\frac{a}{2x}$	h $\frac{-2y}{4a}$ $=$ $-\frac{y}{2a}$

Key ideas

- We simplify algebraic division by writing it as a then dividing the numerator and denominator by common

1 Simplify these expressions.

a $10y \div 15$

$$= \frac{10y}{15}$$

=

$$\frac{2y}{3}$$

b $8 \div 12m$

$$\frac{2}{3m}$$

c $6x \div 8$

$$\frac{3x}{4}$$

d $9x \div 18$

$$\frac{x}{2}$$

e $3m \div 12$

$$\frac{m}{4}$$

f $5p \div 25$

$$\frac{p}{5}$$

g $10c \div 2$

$$5c$$

h $8a \div 4$

$$2a$$

i $6a \div 12$

$$\frac{a}{2}$$

2 Simplify these expressions.

a $\frac{5f}{10e}$

$$\frac{f}{2e}$$

b $\frac{6k}{8m}$

$$\frac{3k}{4m}$$

c $\frac{9c}{6}$

$$\frac{3c}{2}$$

d $\frac{7x}{7}$

$$x$$

e $\frac{6ab}{2}$

$$3ab$$

f $-\frac{3ab}{9}$

$$-\frac{ab}{3}$$

g $\frac{8b}{12}$

$$\frac{2b}{3}$$

h $-\frac{2a}{6}$

$$-\frac{a}{3}$$

i $\frac{4ab}{6}$

$$\frac{2ab}{3}$$

j $\frac{10}{12x}$

$$\frac{5}{6x}$$

k $\frac{4t}{8}$

$$\frac{t}{2}$$

l $\frac{9w}{15ay}$

$$\frac{3w}{5ay}$$

m $\frac{16tu^2}{3}$

$$\frac{16tu^2}{3}$$

n $\frac{5r^2}{25d}$

$$\frac{r^2}{5d}$$

o $\frac{12e^2}{18h}$

$$\frac{2e^2}{3h}$$

FACTORS OF TERMS: ALGEBRAIC HCF

- The **algebraic HCF** is the largest term that divides two terms evenly.
- To find the algebraic HCF:
 - Find the HCF of the numbers.
 - Find the HCF of the pronumerals.
 - Multiply these HCFs together.

Example Identify the algebraic HCF.

Identify the highest common factor of:	What is a factor?
xy and x HCF is x	<i>A factor can into a term with no</i>
$2xy$ and $6x$ HCF is $2x$	In the 2 nd example, why is the HCF not 2?
$14x^2$ and $21x$ HCF is $7x$	<i>2 is not the common factor. $2xy$ and $6x$ can both be divided by</i>

Identify the highest common factor of:

a $5x$ and $2xy$	b $7xy$ and $14x$	c $-2yz$ and $4xy$
d $11y$ and $-33xy$	e $2xy$ and y^2	f $5ab$ and $10a^2b$
x	$7x$	$2y$
$11y$	$2y$	$5ab$

Key ideas

- The highest common factor of two terms can be found by finding the HCF of the and finding the HCF of the, then multiplying them.
- We simplify algebraic division by writing it as a then dividing the numerator and denominator by common

1 Find the highest common factor of the following pairs of terms.

a $5x$ and $7x$	b $20a$ and $12b$	c $27a$ and $9b$
x	4	9
d $7xy$ and $14x$	e $-2xy$ and $4xy$	f $11xy$ and $-33xy$
$7x$	$2xy$	$11xy$
g $8qr$ and $-4r$	h $5a$ and $6a^2$	i $14p$ and $25pq$
$4r$	a	p
j $6x$ and $12xy$	k $-3a$ and $6a^2$	l abc and b^2c
$6x$	$3a$	bc

2 Find the HCF.

a x and $2x$	f $3x^2$ and $2y$	k $8x^2$ and $12x^5y$
x	1	$4x^2$
b x and $3x$	g $7x^2$ and $2y$	l $8x^2y$ and $12x^5y$
x	1	$4x^2y$
c x and $3x^2$	h $7x^2$ and $2xy$	m $16x^2y$ and $24x^5y$
x	x	$8x^2y$
d $3x^2$ and x	i $8x^2$ and $2xy$	n $16x^2y^3$ and $24x^5y$
x	$2x$	$8x^2y$
e $3x^2$ and $2x$	j $8x^2$ and $2x^5y$	o $16x^2y^3$ and $24x^5y^3$
x	$2x^2$	$8x^2y^3$

DIVIDING TERMS: ALGEBRAIC HCF

- To simplify expressions involving division:
 - Write divisions as fractions.
 - Divide the numerator and denominator by common factors.
Also known as “cancelling.”

Example Simplify expressions involving division (algebraic HCF).

$4ab \div 3a = \frac{4ab \div a}{3a \div a}$ $= \frac{4b}{3}$	How did we know to divide the numerator and denominator by a? a is a of $4ab$ and $3a$
$8ab \div 12b = \frac{8ab \div b}{12b \div b}$ $= \frac{8a \div 4}{12 \div 4}$ $= \frac{2a}{3}$	What is the HCF of $8ab$ and $12b$? The HCF of $8ab$ and $12b$ is What did we divide the numerator and denominator by in each line of working out? First, we divided by, then we divided by

a $8m \div 3m$ $= \frac{8m \div}{3m \div}$ $=$	b $6a \div 12a$	c $3ab \div 2b$	d $6x \div 8xy$
$\frac{8}{3}$	$\frac{1}{2}$	$\frac{3a}{2}$	$\frac{3}{4y}$
e $\frac{2x}{5x}$	f $-\frac{5a}{9a}$	g $\frac{9ab}{4b}$	h $\frac{2ab}{-5a}$
$\frac{2}{5}$	$-\frac{5}{9}$	$\frac{9a}{4}$	$\frac{2b}{-5}$
i $\frac{a^2}{a}$	j $\frac{x}{x^2}$	k $\frac{2x^2}{6x}$	l $\frac{6x^2}{4y}$
a	$\frac{1}{x}$	$\frac{x}{3}$	$\frac{3x^2}{2y}$

Key ideas

- We simplify algebraic division by writing it as a then dividing the numerator and denominator by common

1 Simplify these expressions.

a $\frac{3f}{7ef}$	b $\frac{4m}{5m}$	c $\frac{3c}{7ec}$
$\frac{3}{7e}$	$\frac{4}{5}$	$\frac{3}{7e}$
d $\frac{2d^2}{d}$	e $\frac{8abc}{2ab}$	f $\frac{4ab}{2a}$
$2d$	$4c$	$2b$
g $\frac{6q^2y}{11q}$	h $\frac{abc}{ab^2c}$	i $\frac{x^2}{5x}$
$\frac{6qy}{11}$	$\frac{1}{b}$	$\frac{x}{5}$
j $\frac{4t}{6t}$	k $\frac{10k}{2kn}$	l $\frac{3ab}{12b}$
$\frac{2}{3}$	$\frac{5}{n}$	$\frac{a}{4}$
m $\frac{t}{3t}$	n $-\frac{15xy}{5y}$	o $\frac{-28ab}{56b}$
$\frac{1}{3}$	$-3x$	$-\frac{a}{2}$
p $\frac{15h}{5h^2}$	q $\frac{4a^2v}{6v^2}$	r $\frac{9fg}{7g^2}$
$\frac{3}{h}$	$\frac{2a^2}{3v}$	$\frac{9f}{7g}$

2 Simplify these expressions.

a $\frac{3}{12}$	$\frac{1}{4}$	i $\frac{10x}{12xy}$	$\frac{5}{6y}$
b $\frac{3x}{12}$	$\frac{x}{4}$	j $\frac{10x}{12xy^2}$	$\frac{5}{6y^2}$
c $\frac{3}{12x}$	$\frac{1}{4x}$	k $\frac{10xy}{12xy^2}$	$\frac{5}{6y}$
d $\frac{12x}{3}$	$4x$	l $\frac{10x^2y}{12xy^2}$	$\frac{5x}{6y}$
e $\frac{12x}{6}$	$2x$	m $\frac{10x^2y^2}{12xy^2}$	$\frac{5x}{6}$
f $\frac{12x}{6x}$	2	n $\frac{10x^2y^3}{12xy^2}$	$\frac{5xy}{6}$
g $\frac{12xy}{6x}$	$2y$	o $\frac{100x^2y^4}{120xy^2}$	$\frac{5xy^2}{6}$
h $\frac{6x}{12xy}$	$\frac{1}{2y}$	p $\frac{100x^2y^4}{xy^2}$	$100xy^2$

3 Simplify these expressions.

a	$2x \times 3$	j	$\frac{24x^2y^3}{2x}$	$12xy^3$
b	$2 \times 3x$	k	$\frac{24x^2y^3}{2y}$	$12x^2y^2$
c	$2x \times 3x$	l	$\frac{24x^2y^3}{2y^2}$	$12x^2y$
d	$2x \times 3x^2$	m	$\frac{24x^2y^3}{2xy}$	$12xy^2$
e	$2x \times 3x^2 \times 4$	n	$\frac{24x^2y^3}{6xy}$	$4xy^2$
f	$2x \times 3x^2 \times 4y$	o	$\frac{24x^2y^3}{6x^2}$	$4y^3$
g	$2y \times 3x^2 \times 4y$	p	$\frac{24x^2y^3}{6y^2}$	$4x^2y$
h	$2y^2 \times 3x^2 \times 4y$	q	$\frac{24x^2y^3}{6x^2y}$	$4y^2$
i	$\frac{2y^2 \times 3x^2 \times 4y}{2}$	r	$\frac{24x^2y^3}{24x^2y^3}$	1

4 Simplify these expressions.

a	$48x^2y^3 \div 4$	b	$48x^2y^3 \div 8$	c	$48x^2y^3 \div 4x$
d	$48x^2y^3 \div 8y$	e	$48x^2y^3 \div 12xy$	f	$48x^2y^3 \div 6x^2$
g	$48x^2y^3 \div 6y^2$	h	$48x^2y^3 \div 16x^2y^2$	i	$48x^2y^3 \div 48x^2y^3$

MIXED PRACTICE

Adding & Subtracting	Multiplying	Dividing
1. Identify like terms 2. Add the like terms $\textcircled{2xy} + 5x - \textcircled{4xy}$ $= -2xy + 5x$	1. Multiply numbers 2. Multiply pronumerals $\textcolor{blue}{4x} \times \textcolor{blue}{-3y}$ $= \textcolor{blue}{-12xy}$	1. Rewrite as fraction 2. Divide numerator and denominator by common factors $\frac{8ab \div 4b}{12b \div 4b}$ $= \frac{2a}{3}$

FOUNDATION

1 Simplify the following expressions by collecting like terms.

a $3x + 2x$	b $7a + 12a$	c $15x - 6x$
$5x$	$19a$	$9x$
d $4xy + 3xy$	e $16uv - 3uv$	f $10ab + 4ba$
$7xy$	$13uv$	$14ab$
g $11ab - 5ba + ab$	h $3k + 15k - 2k$	i $15k - 2k - 3k$
$7ab$	$16k$	$10k$
j $7f + 2f + 8 + 4$	k $10x + 3x + 5y + 3y$	l $2a + 5a + 13b - 2b$
$9f + 12$	$13x + 8y$	$7a + 11b$
m $10 + 5x - 2 + 7x$	n $10x + 31y - y + 4x$	o $7x^2y + 5x + 10yx^2$
$12x + 8$	$14x + 30y$	$17x^2y + 5x$
p $12xy - 3yx + 5xy - yx$	q $-4x^2 + 3x^2$	r $-2a + 4b - 7ab + 4a$
$13xy$	$-x^2$	$2a + 4b - 7ab$

2 Simplify the following.

a $5 \times 2m$	b $3 \times 5p$	c $3x \times 2y$
$10m$	$15p$	$6xy$
d $3p \times 6r$	e $-2x \times 7y$	f $-4c \times 3d$
$18pr$	$-14xy$	$-12cd$
g $2a \times 3b \times 5$	h $-4r \times 3 \times 2s$	i $5j \times (-4) \times 2k$
$30ab$	$-24rs$	$-40jk$

3 Simplify these expressions.

a $\frac{2x}{5x}$ $\frac{2}{5}$	b $\frac{5a}{9a}$ $\frac{5}{9}$	c $\frac{9ab}{4b}$ $\frac{9a}{4}$
d $\frac{2ab}{5a}$ $\frac{2b}{5}$	e $\frac{2x}{4}$ $\frac{x}{2}$	f $\frac{9x}{12}$ $\frac{3x}{4}$
g $\frac{10a}{15a}$ $\frac{2}{3}$	h $\frac{30y}{40y}$ $\frac{3}{4}$	i $\frac{4a}{2}$ $2a$
j $\frac{21x}{7x}$ 3	k $\frac{4xy}{2x}$ $2y$	l $\frac{9x}{3xy}$ $\frac{3}{y}$
m $\frac{-5x}{10yz^2}$ $-\frac{x}{2yz^2}$	n $\frac{12y^2}{-18y}$ $-\frac{2y}{3}$	o $\frac{-4a^2}{8ab}$ $-\frac{a}{2b}$
p $\frac{12p}{-3q}$ $-\frac{4p}{q}$	q $\frac{-21p}{-3p}$ 7	r $\frac{-15z}{-20z^2}$ $\frac{3}{4z}$

4 Simplify the following:

a $4n \times 6n$ $24n^2$	b $5s \times 2s$ $10s^2$	c $7a \times 3ab$ $21a^2b$
d $-4b \times 2d$ $-8bd$	e $-3mn \times mn \times 4n$ $-12m^2n^3$	f $9k \times (-7)$ $-63k$
g $5mn \times (-3n)$ $-15mn^2$	h $-3gh \times (-6g)$ $18g^2h$	i $3xy \times 4xy$ $12x^2y^2$
j $-4ab \times (-2ab)$ $8a^2b^2$	k $-2mn \times 3m$ $-6m^2n$	l $5hj \times (-4h) \times 2k$ $-40h^2jk$
m $\frac{-3xy}{6y}$ $-\frac{x}{2}$	n $\frac{21xz}{-7xy}$ $-\frac{3z}{y}$	o $\frac{-12y}{-3y^2}$ $\frac{4}{y}$

5 Simplify these expressions, if possible.

a $3 + b$	h $b \times 3$	o $3a \times b^2$
b $3 \times b$ can't simplify	i $2b \times 3$ 3b	p $3a \times a^3$ 3ab²
c $b + b + b$ 3b	j $3 \times 2b$ 6b	q $3a \times ba^2$ 3a⁴
d $b \times b \times b$ 3b	k $3b \times 2b$ 6b	r $2 \times b \times a$ 3a³b
e $b \times a \times b$ b³	l $3b + 2b$ 6b²	s $2 + b + a$ 2ab
f $b + a + b$ ab²	m $3a + 2b$ 5b	t $2 \times b + a$ can't simplify
g $b + 3 + b$ a + 2b	n $3a \times 2b$ can't simplify	u $2 + b \times a$ 2b + a
2b + 3	6ab	2 + ab

6 Simplify these expressions.

a $9m + m$ 10m	b $9m \times m$ 9m²	c $9m \div m$ 9
d $9m + 3m$ 12m	e $9m \times 3m$ 27m²	f $9m \div 3m$ 3
g $4ab \times 2ab$ 8a²b²	h $4ab \div 2ab$ 2	i $4a^2b \times 2ab^2$ 8a³b³
j $4a^2b \div 2a^2b$ 2	k $24a^3b \div 6ab$ 4a²	l $24a^3b \times 6ab$ 144a⁴b²
m $12pq + 6pq$ 18pq	n $12pq \div 6$ 2pq	o $12pq \times 6q$ 72pq²
p $12pq \times 6p$ 72p²q	q $12pq \times 6pq$ 72p²q²	r $12pq \div 6p$ 2q
s $12pq \div 6pq$ 2	t $12p^2q \times 6pq$ 72p³q²	u $12pq^2 \div 6pq$ 2q

- 7 Match any pair of equivalent expressions by circling, underlining etc.
There may be expressions with more than one match or that do not have a match.

$$2t$$

$$t \times t$$

$$t^2$$

$$t + t$$

$$0.5t$$

$$\frac{t}{2}$$

$$3t - t$$

$$t + 2$$

$$2 + t$$

$$t$$

$$5x, 2x + 3x, x + x + x + x + x$$

$$5 + x, x + 5$$

$$\frac{x}{5}, \frac{1}{5}x$$

- 8 Simplify each expression, if possible.

a $5x^2 - 4xy^2$

can't simplify

b $3a^2b + 4ba^2$

$$7a^2b$$

c $8m^2n - 6nm^2 + m^2n$

$$3m^2n$$

d $7p^2q^2 - 2p^2q^2 - 4p^2q^2$

$$p^2q^2$$

e $2x^2y - 4xy^2 + 5yx^2$

$$7x^2y^2 - 4xy^2$$

f $10rs^2 + 3rs^2 - 6r^2s$

$$13rs^2 - 6r^2s$$

g $x^2 - 7x - 3x^2$

$$-2x^2 - 7x$$

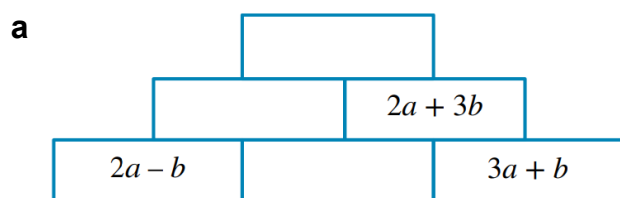
h $a^2b - 4ab^2 + 3a^2b + b^2a$

$$4a^2b - 3ab^2$$

i $10pq^2 - 2qp - 3p^2q - 6$

can't simplify

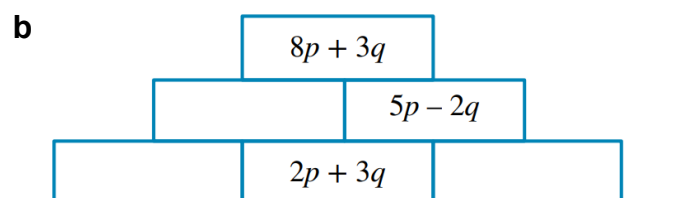
- 9 Fill in the empty bricks in the following pyramids.
Each brick is made by **adding** the expressions in the two bricks below it.



$$3a + 4b$$

$$a + b$$

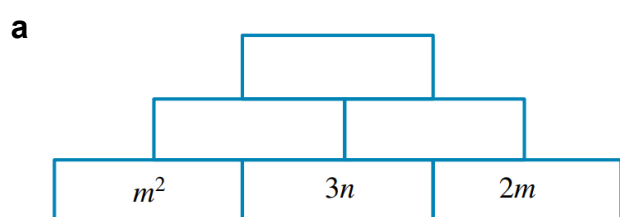
$$-a + 2b$$



$$3p + 5q$$

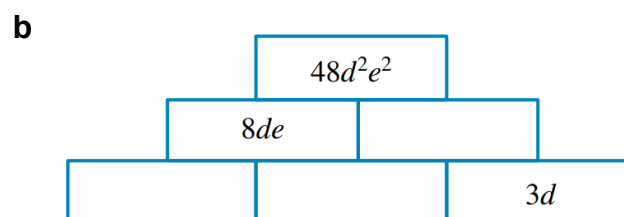
$$p + 2q, 3p - 5q$$

- 10 Fill in the empty bricks in the following pyramids.
Each brick is made by **multiplying** the expressions in the two bricks below it.



$$18m^3n^2$$

$$3m^2n, 6mn$$



$$6de$$

$$4d, 2e$$

11 Find the missing numbers to make these equations true.

a

$$3x \times \square \times z = 6xyz$$

2y

b

$$4a \times \square = 12ab^2$$

3b²

c

$$-2q \times \square \times 4s = 16qs$$

-2

d

$$\frac{\square}{4r} = 7s$$

28rs

e

$$\frac{\square}{2ab} = 4b$$

8ab²

f

$$\frac{14xy}{\square} = -2y$$

-7x

12 Fill in the empty boxes.

a

$$11t + 3 - \square = 7t + 3$$

4t

b

$$\square + 3y - 2x = 7x + 3y$$

9x

c

$$3x + 4y - \square + 5y = x + 9y$$

2x

d

$$4a + 7b - \square - 2b = 5b - 3a$$

-7a

e

$$3mn - \square + nm + 4n = 4mn - n$$

5n

f

$$2pq + 2p - \square - 5pq = 2p - 7pq$$

4pq

g

$$3x^2y - 11xy + 3yx^2 - \square = 6x^2y - 13xy$$

2xy

h

$$4b^2 - 3b + 2b^2 + \square = 6b^2$$

3b

13 Fill in the empty boxes.

a

$$3m \times \square = 12mn$$

4n

b

$$4x \times \square = 28xy$$

7y

c

$$-2xy \times \square = -18xy^2$$

9y

d

$$6a \times \square = 30a^2b$$

5ab

e

$$\frac{\square}{7} = 2x$$

14x

f

$$\frac{15}{\square} = \frac{3}{2y}$$

10y

g

$$\frac{\square}{18ab} = \frac{2}{3b}$$

12a

h

$$\frac{\square}{4x} = 2xy$$

8x²y

14 Fill in the empty boxes.

a

$$8x + 4 - \square = 3x + 4$$

5x

b

$$3x + 2y - \square + 4y = 3x - 2y$$

8y

c

$$3b \times \square = 12ab$$

4a

d

$$4xy \times (\square) = -24x^2y$$

-6x

e

$$12xy \div (\square) = 6y$$

2x

f

$$\square \div (15ab) = \frac{2a}{3}$$

10a²b

15 Jimmy has done his homework. All of his simplifications are incorrect. Write the correct simplifications.

a $3a + 7a \equiv 10a^2$

b $8b - 4b \equiv 2b$

c $6c - 2c \equiv 4$

d $2d \times 3d \equiv 6d$

e $3x + x \equiv 3x^2$



a

10a

b

4b

c

4c

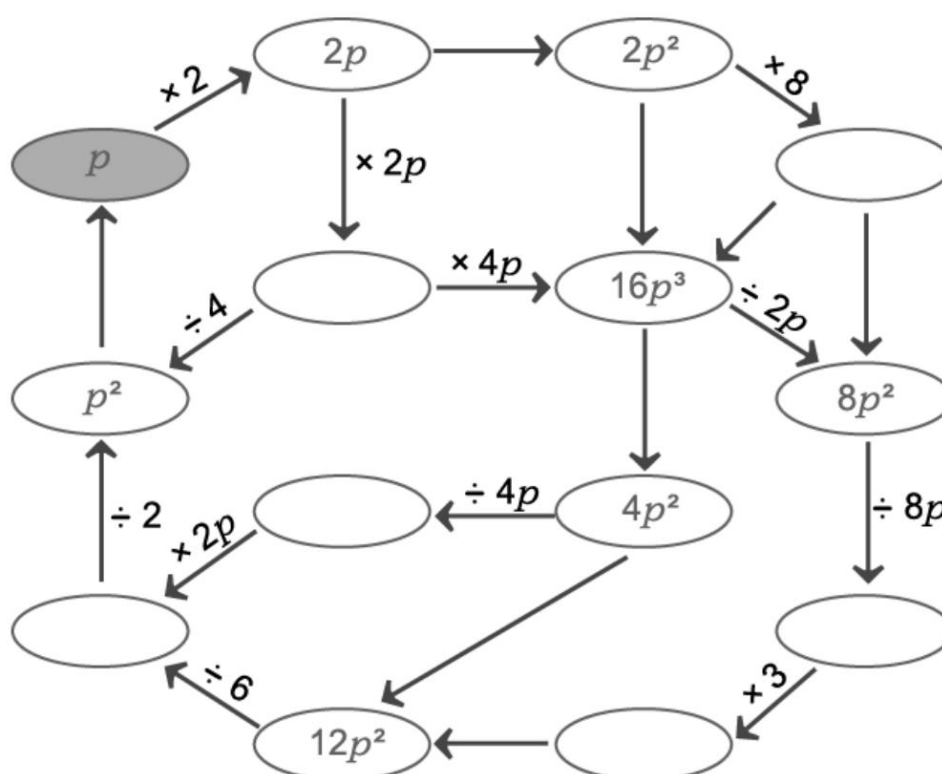
d

6d²

e

4x

16 Complete the diagram.



- 17** The pronumeral e represents the number of eggs in a basket.
Match the expressions to the appropriate scenario. There can be more than one answer.

$2e + 2$	$e + 2$	$2 \times e$	$e - e$	$e \times 2$	$2e + 4$
$e + 1 - 1$	$\frac{1}{2}e$	$e - 1 - 1$	$e + e$	$2(e + 2)$	$e - 2$
$2 + e$	$e \div 2$	$e + e + 2$	0	$\frac{e}{2}$	$e + 1 + 1$
$2e$					

a Two eggs are added.

$$\begin{array}{l} e + 1 + 1 \\ e + 2 \\ 2 + e \end{array}$$

b Two eggs are removed.

$$\begin{array}{l} e - 2 \\ e - 1 - 1 \end{array}$$

c The number of eggs is doubled.

$$\begin{array}{l} 2e \\ e + e \\ e \times 2 \\ 2 \times e \end{array}$$

d The number of eggs is halved.

$$\begin{array}{l} \frac{1}{2}e \\ \frac{2}{2}e \\ \frac{e}{2} \\ e \div 2 \end{array}$$

e The number of eggs is doubled and then two are added.

$$\begin{array}{l} 2e + 2 \\ e + e + 2 \end{array}$$

f Two eggs are added and then that number is doubled

$$\begin{array}{l} 2(e + 2) \\ 2e + 4 \end{array}$$

g All eggs are taken out of the basket.

$$\begin{array}{l} e - e \\ 0 \end{array}$$

h One egg is added and then taken back out.

$$e + 1 - 1$$

SIMPLIFYING EXPRESSIONS WITH MIXED OPERATIONS

- For **mixed operations**, simplify by following the **order of operations**.

Example Simplify expressions with mixed operations.

$\underline{a \times 4} - \underline{2 \times a}$ $= 4a - 2a$ $= 2a$	Which operations did we simplify first in this example? <i>We simplified before</i>
$4b + \underline{(2x + 4x) \div 3}$ $= 4b + 6x \div 3$ $= 4b + 2x$	Why did we do $2x + 4x$ first? <i>$2x + 4x$ was inside</i>

Simplify these expressions.

a $10x + 15x \div 5$	b $3b - 2b \times 4$	c $3 \times 2x + 5x \times 3$
$13x$	$-5b$	$21x$
d $2 \times (6b - 3b)$	e $(2x + x) \div 5$	f $(2 + x) \div (3y + y)$
$6b$	$\frac{3x}{5}$	$\frac{2 + x}{4y}$

Key ideas

- If there are mixed operations in an algebraic expression, then we simplify by following the

1 Simplify these expressions. Remember to follow the order of operations.

a $3 + a \times b$	b $(4x + 2x) \div 5$
$3 + ab$	$\frac{6x}{5}$
c $(2x + y) \div 5$	d $(2 + x) \div (4y + y)$
$\frac{2x + y}{5}$	$\frac{2 + x}{5y}$
e $(x - 5) \div (3 + b)$	f $2x + y \div 5$
$\frac{x - 5}{3 + b}$	$2x + \frac{y}{5}$
g $3 + x \div 2 + y$	h $x - 5 \div 3 + b$
$3 + \frac{x}{2} + y$	$x - \frac{5}{3} + b$
i $3 \times 2b - b$	j $3 \times (2b - 2b)$
$5b$	0
k $6b + 15b \div 3$	l $(6b + 15b) \div 3$
$11b$	$7b$
m $(c - 2c) \times 4$	n $c - 2c \times 4$
$-4c$	$-7c$

2 Simplify the following expressions.

a $5p^2 - 2p \times 3p$	b $4r^2 + 15r^3 \div 5r$	c $4b + 3 \times (2b^3 \div b^2)$
$-p^2$	$7r^2$	$7b$
d $2x + \frac{x^2}{x}$	e $\frac{12x^2y}{3x} - 3xy$	f $\frac{16x^2y^2}{8xy} - xy + y$
$3x$	xy	$xy + y$

- 1 Pens cost \$3 each.

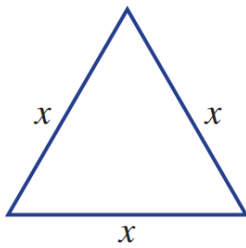
a Write an expression for the total cost, in dollars, of n pens.

$\$3n$

b If $n = 12$, find the total cost.

$\$36$

- 2 An equilateral triangle has three sides of the same length.



a Write an expression that gives the perimeter of this triangle.

$3x$

b Use your expression to find the perimeter if $x = 5$ cm

15 cm

- 3 A rectangle has length **5 cm longer** than its width.



a If the width is x cm, write an expression for the length.

$x + 5$

b Write an expression for the perimeter of the rectangle.

$4x + 10$

c Find the perimeter of the width is 3 cm ($x = 3$).

22

- 4 A rectangle has length **5 times as long** as its width.

a If the width is x cm, write an expression for the length.

$5x$

b Write an expression for the perimeter of the rectangle.

$12x$

c Find the perimeter of the width is 3 cm ($x = 3$).

36 cm

- 5 A car travels at 90 km/h, so in n hours it has travelled $90n$ kilometres.

a How far does the car travel in 3 hours (i.e. $n = 3$)?

270 km

b How far does the car travel in 30 minutes?

45 km

c Write an expression for the distance travelled in n hours for a bike with speed 70 km/h.

$70n$

- 6 A carpenter charges a \$40 call-out fee and then \$80 per hour. This means the total cost for x hours of work is $\$(40 + 80x)$

a How much would it cost for a 2-hour job (i.e. $x = 2$)?

\$200

b How much would it cost for a job that takes 8 hours?

\$680

c The call-out fee is increased to \$50. What is the new expression for the cost of x hours?

$50 + 80x$

- 7 An electrician charges a call-out fee of \$30 and \$90 per hour.

0 hours would cost \$30

1 hour would cost $\$30 + \90

2 hours would cost $\$30 + \90×2

3 hours would cost $\$30 + \90×3

Which of the following represents the total cost, in dollars, for x hours?

A. $x(30 + 90)$

B. $30x + 90$

C. $30 + 90x$

D. $120x$

- 8 A plumber charges a \$50 call-out fee and \$100 per hour.

a Complete the table below:

Hours (t)	0	1	2	3	4	5
Total Cost						

b Find the total cost, in dollars, if the plumber works for t hours. Give an expression.

$50 + 100x$

c Substitute $t = 30$ into your expression to find how much it will cost for 30 hours of work.

\$3050

- 9 To hire a tennis court, you must pay a \$5 booking fee plus \$10 per hour.

a What is the cost of booking a court for 2 hours?

\$25

b What is the cost, in dollars, of booking a court for x hours? Write an expression.

$10x + 5$

10 Abbey worked for n hours this week at \$25 an hour and received an additional bonus of \$100.

a Write an expression for her total pay this week.

$$25n + 100$$

b What is her total pay if she worked 14 hours this week?

$$\$450$$

11 A plumber says that the cost, in dollars, to hire her for x hours is $50 + 60x$.

a What is her call-out fee?

$$\$50$$

b How much does she charge an hour?

$$\$60$$

c How long would it cost to hire her for 4.5 hours?

$$\$320$$

12 Joanne bought three identical bags each containing the same number of lollipops. She also bought five loose lollipops.

a Draw a diagram to represent this.

b Write an expression for the total number of lollipops.
Let the number of lollipops in each bag be n .

$$3n + 5$$

c If each bag held 25 lollipops, what is the total number of lollipops?

$$80$$

13 Ashley's age is a .

Bella is 3 years older than Ashley.

Cindy is double the age of Ashley.

Daisy is 4 years younger than Cindy.

a Write an expression for the age of Bella.

$$a + 3$$

b Write an expression for the age of Cindy.

$$2a$$

c Write an expression for the age of Daisy.

$$2a - 4$$

d Determine their ages if Ashley is 10 years old.

Bella: 13, Cindy: 20, Daisy: 16

14 Jason has $4y + 2$ lollipops, where y represents the number of lollipops in each bag.

a What does the 4 represent?

number of bags

b What does the 2 represent?

number of loose lollipops

c What does $4y$ represent?

The number of lollipops in all bags

15 For a class party, Lilian buys x biscuits at \$3 each and y cans of drink at \$2 each.

a Write an expression for the total amount of money she spent.

$3x + 2y$

b If Lilian bought 20 biscuits and 12 cans of drink, how much did she spend in total?

\$84

16 Amanda has $\$P$ in her bank account. Write an expression for money each person has if:

a Paul has \$250 more than Amanda in his bank account.

$P + 250$

b Gisele has one third of Amanda's money.

$\frac{P}{3}$

c Vinesh has triple the amount of Paul.

$3(P + 250)$

d Michele has half the amount of money as Gisele.

$\frac{P}{6}$

e Lucy has \$20 less than Gisele.

$\frac{P}{3} - 20$

f If Amanda has \$600 in her account, find how much each person has.

Paul: \$850, Gisele: \$200, Vinesh: \$2550, Michele: \$100, Lucy: \$180

CHECK YOUR UNDERSTANDING

Simplifying by collecting terms

1	$c + c + c + c$						
a	c^4	b	$4 \times c$	c	$4c$	d	c^4
2	$4g + 2g$						
a	$8g$	b	$6g$	c	$6g^2$	d	None of these.
3	$5a + 2b$						
a	$10ab$	b	$7ab$	c	$7 + ab$	d	None of these.
4	$2d^2 + 3d$						
a	$6d^3$	b	$5 + d^3$	c	$5d^3$	d	None of these.
5	$n + 6n$						
a	$6nn$	b	$7n$	c	$6n^2$	d	None of these.
6	$6g - 2h + h$						
a	$4gh^2$	b	$6g + 3h$	c	$6g - 3h$	d	None of these.
7	$w^4 + w^4$						
a	$2w^4$	b	w^8	c	w^{16}	d	$8w$
8	$6n - 4 + 2n + 3$						
a	$8n - 7$	b	$4n + 7$	c	$8n - 1$	d	$4n - 7$
9	$3x + 6y + x - y$						
a	$4x + 5y$	b	$9xy$	c	$4x - 5y$	d	$3x^2 - 6y^2$

Multiplying terms

1	$2 \times b \times 5$			
a	$2b5$	b	$7b$	c $10b$
d	$25b$			
2	$a \times b \times 2 \times a \times 3$			
a	$12ab$	b	$6aab$	c $6ab^2$
d	$6a^2b$			
3	$b \times b \times 4 \times a \times 3 \times b$			
a	$12a^3b$	b	$12ab^3$	c $36ab$
d	$12abbb$			
4	$10a \times 8b$			
a	$81a$	b	$80ab$	c $18ab$
d	$80ab^2$			
5	$3m \times 9$			
a	$12m$	b	$27m$	c $3m9$
d	Can't simplify			
6	$2ab \times 3b$			
a	$6ab^2$	b	$12ab$	c $23abb$
d	$5ab^2$			
7	$4a \times 5a$			
a	$9a$	b	$4a^2$	c $20a$
d	$20a^2$			
8	$(3a)^2$			
a	$9a^2$	b	$6a^2$	c $3a^2$
d	$9a$			
9	$-5p \times -3pq$			
a	$-8p^2q$	b	$8p^2q$	c $-15p^2q$
d	$15p^2q$			

Dividing terms

1	$\frac{20x}{4}$	a	$5x$	b	5	c	$5\frac{x}{4}$	d	$80x$
2	$\frac{18x}{3}$	a	$54x$	b	$6x$	c	6	d	$6\frac{x}{3}$
3	$\frac{35}{7x}$	a	$5x$	b	5	c	$\frac{1}{5x}$	d	$\frac{5}{x}$
4	$\frac{3m}{12}$	a	$-9m$	b	$\frac{1}{4m}$	c	$\frac{1}{4}$	d	$\frac{m}{4}$

Dividing terms

1	$\frac{12f}{36f}$	a	$3f$	b	$\frac{f}{3}$	c	$\frac{1}{3f}$	d	$\frac{1}{3}$
2	$\frac{6a}{4a}$	a	$2a$	b	$\frac{3a}{2a}$	c	$\frac{3}{2}$	d	$\frac{6}{4}$
3	$\frac{6a}{4a^2}$	a	$2a$	b	$\frac{3a}{2}$	c	$\frac{3}{2a}$	d	$\frac{3}{2}$
4	$\frac{20x}{15y^2}$	a	$\frac{4}{3}$	b	$\frac{4}{3y}$	c	$\frac{4x}{3y^2}$	d	$\frac{2x}{3y}$
5	$3m \div 12m$	a	$-9m$	b	0.25	c	4	d	0.25

Simplifying with mixed operations

1	$p + p \times q$			
a	$2pq$	b	p^2q	c $p + pq$ d Can't simplify
2	$p \times p + q$			
a	$2pq$	b	$p^2 + q$	c p^2q d Can't simplify
3	$r \times r - s \times s$			
a	$2r - 2s$	b	$(r - s)^2$	c $r^2 - s^2$ d Can't simplify
4	$r - r \times s - s$			
a	$r - s - rs$	b	r^2s^2	c 1 d 0
5	Tom says: $3sr + 4rs = 7rs$ Katie says: $3s \times 4r = 12sr$ Who is correct?			
a	Only Tom	b	Only Katie	c Both d Neither
6	$4a \times 5b - a \times 3b$			
a	$17ab$	b	$-45ab$	c $45ab$ d $-23ab$
7	$3 + 4(m - 2m)$ What is the correct first step?			
a	$3 + 4m - 8m$	b	$7(m - 2m)$	c $3 + 4m + 8m$ d $3 + 4(-m)$