Student Name

Mathematics Stage 5 Core

INDICES A

Book 1 Extend and apply the index las to variables using positive-integer indices and the zero index

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CONTENTS

OVERVIEW

SYLLABUS CONTENT

MA5-IND-C-01 simplifies algebraic expressions involving positive-integer and zero indices, and establishes the meaning of negative indices for numerical bases

Extend and apply the index laws to variables, using positive-integer indices and the zero index

- Apply the index laws for numerical bases with positive-integer indices to develop the index laws in algebraic form
- Establish that $x^0 = 1$ algebraically using index laws
- Simplify algebraic expressions that involve the zero index

REVIEW OF PRIOR KNOWLEDGE

1 Write the following in index form.

a $5 \times 5 \times 5 \times 5$

b $2 \times 2 \times 2 \times 2 \times 2$

c $a \times a \times a \times a \times a$

2 Find the missing numbers.

a $3 \times 3 \times a \times a \times a = 3^{\square}a^{\square}$

b $\square \times \square \times k \times k \times k = 5^2k^{\square}$

c $\frac{2}{7} \times \frac{2}{7} \times \frac{2}{7} = \left(\frac{2}{7}\right)^{\square}$

d $3p^2q = 3 \times \square \times \square \times q$

e $(abc)^1 = a\square b\square c$

3 Complete to give the answer in index form.

a $3^2 \times 3^4 = 3 \times \square \times \square \times \square \times \square \times \square$

$= 3^{\square}$

b $6^4 \times 6^3 = 6 \times \square \times \square \times \square \times 6 \times \square \times \square$

$= 6^{\square}$

4 Simplify these expressions using index laws:

a $2^3 \times 2^2$

b $3^2 \times 3$

c $4^3 \times 4^2 \times 4^7$

5 Simplify these fractions.

a	$\frac{24}{38}$	**b**	$\frac{17}{34}$	**c**	$\frac{44}{11}$
d	$\frac{12}{6}$	**e**	$\frac{15}{20}$	**f**	$\frac{8}{12}$

6 Complete to give the answer in index form.

a $5^5 \div 5^3 = \dfrac{5 \times \square \times \square \times \square \times \square}{5 \times \square \times \square}$

$= 5^{\square}$

b $9^4 \div 9^2 = \dfrac{9 \times \square \times \square \times \square}{9 \times \square}$

$= 9^{\square}$

7 Simplify the following expressions:

a	$7^7 \div 7^5$	**b**	$10^6 \div 10^5$	**c**	$101^5 \div 101^4$
d	$200^{30} \div 200^{28}$	**e**	$31^{16} \div 31^{15}$	**f**	$50^{100} \div 50$

8 Complete the following.

a $(4^2)^3 = \left(4 \times \square\right) \times \left(4 \times \square\right) \times \left(4 \times \square\right)$

$= 4^{\square}$

b $(12^3)^3 = \left(12 \times \square \times \square\right) \times \left(12 \times \square \times \square\right) \times \left(12 \times \square \times \square\right)$

$= 12^{\square}$

INDEX LAW OF MULTIPLICATION

Index Law of Multiplication
$a^m \times a^n = a^{m+n}$

Example Simplify algebraic expressions using multiplication index law.

$x^4 \times x^5$ $= x^{4+5}$ $= x^9$	When can you use the index law of multiplication? *When multiplying two terms where the ..... numbers are the same.*
$x^3y^4 \times x^2y$ $= x^{3+2}y^{4+1}$ $= x^5y^5$	In this example, where did the 1 come from? *When a number does not show ....., it is a power of 1.*
$3m^4 \times 2m^5$ $= 6m^{4+5}$ $= 6m^9$	What do we do with non-base numbers when using the index law of multiplication? *We ..... them separately.*

Simplify these expressions.

a $a^6 \times a^9$ a^{15}	**b** $x^3 \times x^{17}$ x^{20}	**c** $y^3 \times y$ y^4
d $x^3y^3 \times x^4y^2$ x^7y^5	**e** $a^3b^5 \times a^2b^4$ a^5b^9	**f** $4a^2 \times 6a^3$ $24a^5$
g $4e^4f \times 2e^2$ $8e^6f$	**h** $-9x^2 \times 3x^2$ $-27x^4$	**i** $3x^2 \times 2x^3 \times 6x$ $36x^6$

Key ideas

1. The index law of multiplication says that when you multiply two expressions with the same ....., we add the .....

1 Find the missing numbers.

a $3^2 \times 3^4 = 3 \times \square \times 3 \times \square \times \square \times \square$
$= 3^{\square}$

3^6

b $6^4 \times 6^3 = 6 \times \square \times \square \times \square \times 6 \times \square \times \square$
$= 6^{\square}$

6^7

c $k^3 \times k^2 = k \times \square \times \square \times \square \times \square$
$= k^{\square}$

k^5

d $m^4 \times m^3 = m \times \square \times \square \times \square \times \square \times \square \times \square$
$= m^{\square}$

m^7

e $5^3 \times 5 = \square \times \square \times \square \times \square$
$= \square^{\square}$

5^4

f $2 \times 2^4 = \square \times \square \times \square \times \square \times \square$
$= \square^{\square}$

2^5

2 Write each of these using a single power.

a $x^2 \times x^5$

x^7

b $y^3 \times y^4$

y^7

c $a^5 \times a^6$

a^{11}

d $4^3 \times 4^5$

4^8

e $5^3 \times 5$

5^4

f $b^3 \times b^2 \times b^4$

b^9

g $e^3 \times e^4 \times e^6$

e^{13}

h $b^4 \times b \times b^2$

b^7

i $n^2 \times n^5 \times n^2 \times n^3$

n^{12}

j $x^4 \times x^{18}$

x^{22}

k $p^{35} \times p^{42}$

p^{77}

3 Laura is simplifying $e^4 \times e^3$.

You multiply the powers, so the answer is e^{12}

Explain why she is incorrect and state the correct answer.

When multiplying the same base numbers, we add the powers.

e^7

4 Julie is simplifying $w^4 \times w$

The answer is w^4 since the second w has no power.

Explain why she is incorrect and state the correct answer.

The second power has a power of 1.

w^5

5 Seb is trying to simplify $2q^4 \times 4q^5$

The answer is $6q^9$

Explain why Seb is incorrect and state the correct answer.

We multiply the non-base numbers. $8q^9$

6 Simplify each of these expressions.

a	**i** $x^4 \times x^2$ x^6	**ii** $-x^4 \times x^2$ $-x^6$	**iii** $-x^4 \times -x^2$ x^6	
b	**i** $2m^3 \times m^2$ $2m^5$	**ii** $m^3 \times 2m^2$ $2m^5$	**iii** $3m^3 \times 2m^2$ $6m^5$	**iv** $5m^3 \times 4m^2$ $20m^5$

7 Explain why you can't simplify $x^2 \times y^3$ using index laws.

The bases are not the same.

8 Write as a single power, if possible.

a $7^9 \times 7^6$ 7^{15}	**b** $y^9 \times y^6$ y^{15}	**c** $a^9 \times b^6$ Can't simplify
d $(2x+3)^9 \times (2x+3)^6$ $(2x+3)^{15}$	**e** $(\sqrt{7})^9 \times (\sqrt{7})^6$ $(\sqrt{7})^{15}$	**f** $9^7 \times 6^7$ Can't simplify

9 Simplify the following expressions.

a $f^3 \times h^3 \times f^4 \times h^4$ f^7h^7	**b** $3m^2n \times m^8$ $3m^{10}n$	**c** $a^2b^3 \times a^3b^2$ a^5b^5
d $x^5y^2 \times y^4x^3$ x^8y^6	**e** $m^2n^3 \times mn^4$ m^3n^7	**f** $3c^{12}d^5 \times c^4d^5$ $3c^{16}d^{10}$
g $6gh^4 \times 2h^3$ $12gh^7$	**h** $7a^3b^3c^2 \times b^5c^6$ $7a^3b^8c^8$	**i** $x^4 \times y^3$ x^4y^3
j $u^4v^7 \times u^8 \times v^6$ $u^{12}v^{13}$	**k** $(x+3)^2 \times (x+3)^9$ $(x+3)^{11}$	**l** $(b+c) \times (b+c)^6$ $(b+c)^7$

10 Work out the missing powers.

a $x^3 \times x^{\square} = x^5$ — 2

b $4^{\square} \times 4^2 = 4^6$ — 4

c $y^5 \times y^{\square} = y^{17}$ — 12

d $h^{\square} \times h^4 = h^5$ — 1

e $3^4 \times 3^{\square} = 3^9$ — 5

f $k^{\square} \times k^5 = k^{19}$ — 14

g $10^4 \times 10^{\square} \times 10 = 10^8$ — 3

11 Simplify the following using index laws.

a $x^3y^3 \times x^4y^2$ — x^7y^5

b $-x^7y^3 \times x^2y$ — $-x^9y^4$

c $5x^3y^5 \times xy^4$ — $5x^4y^9$

d $xy^4z \times 4xy$ — $4x^2y^5z$

e $-3m^3 \times 5m^2$ — $-15m^5$

f $4e^2f^2 \times 2e^2f^2$ — $8e^4f^4$

g $5c^4d \times 4c^3d$ — $20c^7d^2$

h $-9yz^2 \times -2yz^5$ — $18y^2z^7$

i $6m^{12} \times 3mn$ — $18m^{13}n$

j $3x^4 \times 2x^3 \times 3x$ — $18x^8$

k $-9x^5 \times 3x^2$ — $-27x^7$

l $(-3m^3n^2) \times (-4mn^7)$ — $12m^4n^9$

12 Expand these brackets.

a $3x^5(2x^7 + 11)$ — $6x^{12} + 33x^5$

b $4a^3(3b^{10} - 12a^8)$ — $12a^3b^{10} - 48a^{11}$

c $6x^2y(5xy^5 + 3x^7 - y)$ — $30x^3y^6 + 18x^9y - 6x^2y^2$

13 Write each of these expressions as a single term.

a $2^x \times 2^{3x}$ — 2^{4x}

b $5^{3x-1} \times 5^{7x}$ — 5^{10x-1}

c $r^{2y+3} \times r^{y-2}$ — r^{3y+1}

14 Find the value of x in these equations.

a $3^x \times 3^x = 3^{10}$ — 5

b $5^{x+1} \times 5^{2x} = 5^{13}$ — 4

c $a^x \times a^{4x} \times a^2 = a^{32}$ — 6

d $7^{x-5} \times 49 = 7^6$ — 9

e $m^{2x} \times m^{x-2} = m^x \times m^4$ — 3

INDEX LAW OF DIVISION

Index Law of Division
$\frac{a^m}{a^n} = a^{m-n}$

Example Simplify algebraic expressions using division index law.

$x^{10} \div x^2$ $= x^{10-2}$ $= x^8$	When can we use the index law of division? *When dividing two terms where the ..... numbers are the same.*
$\frac{8a^6b^3}{12a^2b^2}$ $= \frac{2a^{6-2}b^{3-2}}{3}$ $= \frac{2a^4b}{3}$	What do we do with non-base numbers when using the index law of division? *We divide them and write them as a ..... fraction.*

Simplify these expressions.

a $a^6 \div a^4$

a^2

b $\frac{q^{12}}{q^2}$

q^{10}

c $\frac{8b^5}{12b^3}$

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

d $9m^3 \div 3m^2$

$3m$

e $\frac{3m^7}{12m^2}$

$\frac{m^5}{4}$

f $\frac{2s^5t^3}{12s^5t}$

$\frac{t^2}{6}$

Key ideas

1. The index law of division says that when you divide two expressions with the same ....., we ..... the indices.

1 Fill in the boxes.

a $5^5 \div 5^3 = \dfrac{5 \times \square \times \square \times \square \times \square}{5 \times \square \times \square}$

$= 5^{\square}$

5^2

b $9^4 \div 9^2 = \dfrac{9 \times \square \times \square \times \square}{9 \times \square}$

$= 9^{\square}$

9^2

c $a^6 \div a^2 = \dfrac{a \times \square \times \square \times \square \times \square \times \square}{\square \times \square}$

$= a^{\square}$

a^4

d $\dfrac{n^6}{n^3} = \dfrac{n \times \square \times \square \times \square \times \square \times \square}{\square \times \square \times \square}$

$= n^{\square}$

n^3

e $x^4 \div x = \dfrac{x \times \square \times \square \times \square}{\square}$

$= x^{\square}$

x^3

f $x^4 \div x^3 = \dfrac{x \times \square \times \square \times \square}{\square \times \square \times \square}$

$= x^{\square}$

$= \square$

x

2 Explain why these two cards give the same answer.

A $\dfrac{g^8}{g^4}$ B $g^8 \div g^4$

The fraction bar represents division

Simplify each expression

a **i** $d^6 \div d^3$ d^3

ii $d^6 \div d^4$ d^2

iii $d^6 \div d^5$ d

b **i** $\dfrac{y^3}{y}$ y^2

ii $\dfrac{y^4}{y}$ y^3

iii $\dfrac{y^5}{y}$ y^4

3 Read the example carefully and answer the questions.

$\dfrac{c^6}{c^2}$

$c^{6 \div 2}$

c^3

This student divided her exponents to get her answer. What operation should they have used to get the correct answer?

subtract

Simplify:

$\dfrac{b^6}{b^3}$

b^3

4 Write each of these with a single power.

a $n^6 \div n^2$ n^4	**b** $x^7 \div x^3$ x^4	**c** $7^5 \div 7^3$ 7^2	**d** $q^4 \div q^3$ q
e $5^4 \div 5$ 5^3	**f** $y^{50} \div y^2$ y^{48}	**g** $e^4 \div e$ e^3	**h** $a^{14} \div a^5$ a^9
i $\frac{x^6}{x^2}$ x^4	**j** $\frac{n^7}{n}$ n^6	**k** $\frac{7^9}{7^5}$ 7^4	**l** $\frac{r^{30}}{r^{10}}$ r^{20}

5 Simply each of the following.

a $x^8 \div x^2$ x^6	**b** $-x^8 \div x^2$ $-x^6$	**c** $-x^8 \div -x^2$ x^6
d $10m^6 \div m^2$ $10m^4$	**e** $10m^6 \div 2$ $5m^6$	**f** $10m^6 \div 2m^2$ $5m^4$

6 Explain why you can't simplify $\frac{g^7}{m^4}$

The bases are not the same.

7 Emily says:

$8^{17} \div 8^{15} = 1^2$

Explain why she is incorrect and state the correct answer.

The base number does not change.

8^2

8 Look at the example and then answer the questions.

$$\frac{h^{\cancel{9}\,5}}{\cancel{h^4}} = h^5 \qquad \frac{\cancel{h^3}}{h^{\cancel{7}\,4}} = \frac{1}{h^4}$$

When happens when numerator has a higher power?

We find the difference of the powers and the base is in the numerator.

What happens when the denominator has a higher power?

We find the difference of the powers and the base is in the denominator.

9 Simplify these.

a $\frac{n^3}{n^5} = \frac{\square}{\square}$ $\frac{1}{n^2}$

b $\frac{n^5}{n^3} = \square$ n^2

c $\frac{a^7}{a^2} = \square$ a^5

d $\frac{a^2}{a^7} = \frac{\square}{\square}$ $\frac{1}{a^5}$

e $\frac{x}{x^4} = \frac{\square}{\square}$ $\frac{1}{x^3}$

f $\frac{x^4}{x} =$ x^3

g $\frac{y^5}{y^4} =$ y

h $\frac{y^4}{y^5} =$ $\frac{1}{y}$

i $\frac{b^2}{b^9} =$ $\frac{1}{b^7}$

j $\frac{b^9}{b^2} =$ b^7

k $\frac{c^5}{c^8} =$ $\frac{1}{c^3}$

l $\frac{k^2}{k^7} =$ $\frac{1}{k^5}$

10 Look at the example and then answer the questions.

$$\frac{b^{\cancel{2}}e^{\cancel{2}}}{b^{\cancel{3}}e^{\cancel{4}\,2}} = \frac{1}{be^2} \qquad \frac{b^{\cancel{5}}e^{\cancel{5}\,2}}{b^{\cancel{e}^{\cancel{3}}}} = b^4e^2$$

a $\frac{ab^9}{b^7} = \square$ ab^2

b $\frac{b^9}{ab^7} = \frac{\square}{\square}$ $\frac{b^2}{a}$

c $\frac{x^2y^9}{y^7} = \square$ x^2y^2

d $\frac{x^2y^9}{xy^7} = \square$ xy^2

e $\frac{a^2n^9}{a^2n^8} = \square$ n

f $\frac{a^5n^3}{a^2n^9} = \frac{\square}{\square}$ $\frac{a^3}{n^6}$

g $\frac{bc}{b^2c} = \frac{\square}{\square}$ $\frac{1}{b}$

h $\frac{c^5b^2}{b^2c^3} = \square$ c^2

i $\frac{s^4v}{v^2s^2} =$ $\frac{s^2}{v}$

j $\frac{xy^2}{x^2y} =$ $\frac{y}{x}$

k $\frac{a^4e}{e^2a^3} =$ $\frac{a}{e}$

l $\frac{c^2f^2}{cf^7} =$ $\frac{c}{f^5}$

11 Simplify these pairs of expressions.

a i $\frac{g^8}{g^2}$ ii $\frac{g^2}{g^8}$ g^6, $\frac{1}{g^6}$

b i $\frac{8k^3}{2k}$ ii $\frac{8k}{2k^3}$ $4k^2$, $\frac{4}{k^2}$

c i $\frac{12p^7}{6p^2}$ ii $\frac{6p^2}{12p^7}$ $2p^5$, $\frac{1}{2p^5}$

d i $\frac{12x^5}{9x^4}$ ii $\frac{9x^4}{12x^5}$ $\frac{4x}{3}$, $\frac{3}{4x}$

12 Simplify these expressions.

a $f^8g^3 \div f^2g^2$ f^6g

b $f^8g^2 \div f^2g^3$ $\frac{f^6}{g}$

c $f^2g^3 \div f^8g^2$ $\frac{g}{f^6}$

d $f^2g^2 \div f^8g^3$ $\frac{1}{f^6g}$

13 Simplify the following.

a $\frac{6x^2}{x} =$ $6x$	**b** $\frac{x^2}{6x} =$ $\frac{x}{6}$	**c** $\frac{x}{6x^2} =$ $\frac{1}{6x}$	**d** $\frac{3x}{6x^2} =$ $\frac{1}{2x}$
e $\frac{6x^2}{3x} =$ $2x$	**f** $\frac{6x^2}{3x^2} =$ 2	**g** $\frac{9x^2}{6x} =$ $\frac{3x}{2}$	**h** $\frac{9x}{6x^2} =$ $\frac{3}{2x}$
i $15 \div 15a^2$ $\frac{1}{a^2}$	**j** $2y \div 8y^2$ $\frac{1}{4y}$	**k** $8y^3 \div 6y$ $\frac{4y^2}{3}$	**l** $9y^2 \div 12y^5$ $\frac{3}{4y^3}$

14 Simplify these expressions.

a $\frac{10m^7n^5}{2m^2n^4}$ $5m^5n$	**b** $\frac{12a^4b^5}{8ab^3}$ $\frac{3a^3b^2}{2}$	**c** $\frac{10h^8g^3}{25h^4g^3}$ $\frac{2h^4}{5}$	**d** $20x^2y^3 \div 2xy^5$ $\frac{10x}{y^2}$

15 Simplify the following using index laws.

a $\frac{5w^2x^5}{25wx^3}$ $\frac{wx^2}{5}$	**b** $\frac{7m^7y^4}{21m^2y^2}$ $\frac{m^5y^2}{3}$	**c** $\frac{6a^6b^{16}}{a^3b^7}$ $6a^3b^9$
d $\frac{16x^8y^6}{12x^2y^3}$ $\frac{4x^6y^3}{3}$	**e** $\frac{6s^6t^3}{14s^5t}$ $\frac{3st^2}{7}$	**f** $-\frac{5x^2y}{xy}$ $-5x$

16 Simplify these expressions.

a $7^{5a} \div 7^{2a}$ 7^{3a}	**b** $y^{5x+3} \div y^{2x}$ y^{3x+3}	**c** $y^{2m+3} \div y^{m+5}$ y^{m-2}

17

$12y^3$	$18y^6$	$10y$	12	$10y^4$	$6y^8$	$5y^2$	$2y^4$

a Rhys picks two cards and then divides the expressions. He gets the answer y^3.
Which two cards does he pick? Find two different answers.

$10y^4 \div 10y, 12y^3 \div 12$

b Huda picks two cards and then divides the expressions. She gets the answer $\frac{3}{y^2}$.
Which two cards does she pick?

$18y^6 \div 6y^8$

18 Consider this information:

$2^9 = 512$	$2^{11} = 2048$	$2^{20} = 1\,048\,576$

Use this information to work out the answers to these calculations.

a $1\,048\,576 \div 2048$

512

b $1\,048\,576 \div 512$

2048

19 Work out the missing powers.

a $x^8 \div x^{\square} = x^5$

3

b $4^{\square} \div 4^2 = 4^6$

8

c $y^{10} \div y^{\square} = y^{10}$

0

d $q^{\square} \div q = q^5$

6

20 Evaluate without a calculator.

a $7^7 \div 7^5$

49

b $10^6 \div 10^5$

10

c $13^{11} \div 13^9$

169

d $2^{20} \div 2^{17}$

8

e $7 \times 31^{16} \div 31^{15}$

217

f $3 \times 50^{200} \div 50^{198}$

7500

INDEX LAW OF POWER OF A POWER

Power of a Power
$(a^m)^n = a^{m\times n}$

Example Simplify algebraic expressions using power of power law.

$(x^5)^4$ $= x^{5\times4}$ $= x^{20}$ $3(y^5)^2$ $= 3y^{5\times2}$ $= 3y^{10}$	When can we use the index law of powers? *When raising a term with a …… to another power.* In this example, why is the 3 not affected by the power? *The 3 is not in ……., meaning it is not raised to the power of 2.*

Simplify these expressions.

a $(y^6)^2$ y^{12}	**b** $(m^3)^6$ m^{18}	**c** $5(m^8)^2$ $5m^{16}$
d $(y^5)^3$ y^{15}	**e** $2(u^4)^2$ $2u^8$	**f** $16(m^4)^3$ $16m^{12}$

Key ideas

1. When an expression with a power is raised to another power, then we …… the powers.

1 Complete to give an answer in index form

a $(4^2)^3 = 4^2 \times 4^2 \times 4^2$
$= (4\times\square)\times(4\times\square)\times(4\times\square)$
$= 4^{\square}$

4^6

b $(12^3)^2 = 12^{\square} \times 12^{\square}$
$= (12\times\square\times\square)\times(12\times\square\times\square)$
$= 12^{\square}$

12^6

c $(x^4)^2 = x^{\square} \times x^{\square}$
$= (x\times\square\times\square\times\square)\times(x\times\square\times\square\times\square)$
$= x^{\square}$

x^8

d $(a^2)^3 = a^{\square} \times a^{\square} \times a^{\square}$
$= (a\times\square)\times(a\times\square)\times(a\times\square)$
$= a^{\square}$

a^6

2 Complete the following.

a $(4^2)^3 = 4^2 \times 4^2 \times 4^2 = \square$ 4^6

b $(5^3)^4 = 5^3 \times \square \times \square \times \square = \square$ 5^{12}

c $(d^4)^3 \equiv \square \times \square \times \square \equiv \square$ d^{12}

d $(v^5)^6 \equiv \square \times \square \times \square \times \square \times \square \times \square \equiv \square$ v^{30}

3 Write each of these as a single power.

a	**i** $(5^3)^2$ 5^6	**ii** $(5^3)^3$ 5^9	**iii** $(5^3)^4$ 5^{12}	**iv** $(5^3)^5$ 5^{15}	**v** $(5^3)^6$ 5^{18}
b	**i** $(e^2)^5$ e^{10}	**ii** $(e^3)^5$ e^{15}	**iii** $(e^4)^5$ e^{20}	**iv** $(e^5)^5$ e^{25}	**v** $(e^6)^5$ e^{30}

4 Simplify

a $(x^7)^4$ x^{28}	**b** $(p^4)^2$ p^8	**c** $(v^8)^3$ v^{24}	**d** $(d^6)^3$ d^{18}
e $(t^4)^{10}$ t^{40}	**f** $(x^2)^5$ x^{10}	**g** $(p^6)^5$ p^{30}	**h** $(u^3)^4$ u^{12}
i $(4^2)^4$ 4^8	**j** $(5^3)^9$ 5^{27}	**k** $(22^3)^5$ 22^{15}	**l** $(176.4^{20})^{50}$ $(176.4)^{1000}$

5 Simplify

a $(6^2)^5 =$ 6^{10}

b $(6^3)^5 =$ 6^{15}

c $(6^4)^5 =$ 6^{20}

d $(2^4)^5 =$ 2^{20}

e $(2^5)^4 =$ 2^{20}

f $(2^5)^0 =$ 1

g $(2^5)^{-1} =$ 2^{-5}

h $(2^{-5})^{-1} =$ 2^5

i $(3^{-5})^{-1} =$ 3^5

j $(3^2)^{\frac{1}{2}} =$ 3

k $\left(3^{\frac{1}{2}}\right)^2 =$ 3

l $\left(3^{\frac{1}{2}}\right)^{\frac{1}{2}} =$ $3^{\frac{1}{4}}$

m $(x^2)^2 =$ x^4

n $(x^2)^7 =$ x^{14}

o $(2^7)^x =$ 2^{7x}

p $(7^x)^2 =$ 7^{2x}

q $(x^2)^5 =$ x^{10}

r $(x^2)^a =$ x^{2a}

6 Without simplifying, explain why these expressions are equivalent.

$(r^{273})^{95}$ $(r^{95})^{273}$

You can multiply in any order and the product will be the same.

Work out the missing numbers.

a $(2^{\square})^3 = 2^{12}$ 4

b $(a^{\square})^6 \equiv a^{42}$ 7

c $(g^4)^{\square} \equiv g^{40}$ 10

7 Simplify

a $\left(p^{\frac{1}{9}}\right)^{\frac{2}{5}}$ $p^{\frac{2}{45}}$

b $\left(h^{\frac{3}{4}}\right)^{\frac{9}{10}}$ $h^{\frac{27}{40}}$

8 If m and n are positive integers, list the ways $a^m \times a^n = a^6$

$m = 1, n = 5 \mid m = 2, n = 4 \mid m = 3, n = 3 \mid m = 4, n = 2 \mid m = 5, n = 1$

9 If m and n are positive integers, list the ways $(a^m)^n = a^6$

$m = 1, n = 6 \mid m = 2, n = 3 \mid m = 3, n = 2 \mid m = 6, n = 1$

10 Work out the missing numbers.

a $(x^2)^3 \times x^{\square} = x^{11}$ 5

b $(x^4)^{\square} \times (x^3)^2 = x^{14}$ 2

INDEX LAW OF ZERO

Index Law of Zero
$a^0 = 1$

Example Simplify algebraic expressions using zero index.

$(-x)^0$ $= 1$	When can we use the index law of zero? *When a term is raised to the power of .....* How is the second example different to the first example? *The ..... is not in the brackets.*
$-(x)^0$ $= -1 \times x^0$ $= -1$	In the second example, where did the -1 come from? *In algebra, if there is a ..... symbol in front of a term, that means ..... by -1*
$3y^0$ $= 3 \times 1$ $= 3$	

Simplify these expressions.

a x^0 1	**b** $(-6)^0$ 1	**c** $-(2)^0$ -1
d $-(-8)^0$ -1	**e** $-3p^0$ -3	**f** $-5n^0 + 3^0$ -4

Key ideas

1. When a base number is raised to the power of zero, the answer is .....

1

a Explain why $\frac{3^2}{3^2} = 1$

Anything divided by itself is 1

b Using your answer to part **a**, explain why $3^0 = 1$

$3^2 \div 3^2 = 3^0 = 1$

2 Simplify these expressions using the power of zero.

a $2^0 =$ 1

b $3^0 =$ 1

c $4^0 =$ 1

d $5^0 =$ 1

e $0^5 =$ 0

f $0^4 =$ 0

g $0^0 =$ undefined

h $6^0 =$ 1

i $(-6)^0 =$ 1

j $-(6)^0 =$ −1

k $\left(\frac{1}{6}\right)^0 =$ 1

l $(0.6)^0 =$ 1

m $(6p)^0 =$ 1

n $6p^0 =$ 6

3 Evaluate these. An example is provided.

$$5m^0 + 7$$

$$= 5 \times 1 + 7 = 12$$

a $2v^0$

$= 2 \times 1 =$ 2

b $8h^0$ 8

c $h^0 + 7$ 8

d $7h^0 - 4$ 3

e x^0 1

f $2x^0$ 2

g $2x^0 + 2$ 4

h $x^0 + 2x^0$ 3

i n^0 1

j 4^0 1

k $4n^0$ 4

l $(4n)^0$ 1

m $4n^0 + 4$ 8

n $(n^0 + 4)^2$ 25

o $4n^0 + (4n)^0$ 5

p $4^0 n$ n

4 Study the example and simplify these.

$$(3x^0)^3 = (3\times 1)^3$$
$$= (3)^3$$
$$= 27$$

a $(5n^0)^4 = (\square \times \square)^4$
$= \square^4 = \square$
625

b $(8p^0)^3 = (\square \times \square)^3$
$= \square^3 = \square$
512

c $(2h^0)^9 = (\square \times \square)^9$
$= \square^9 = \square$
512

d $(2h^0)^3$
8

e $(8k^0)^2$
64

f $(3x^0y^0)^4$
81

g $(2h^3)^0$
1

h $(8k^2)^0$
1

i $(3x^2y^4)^0$
1

5 Simplify these expressions.

a $x^0 \times y^0$
1

b $x^0 + y^0$
2

c $a^0 - b^0$
0

d $p \times q^0$
p

e $x + y^0$
$x + 1$

f $2x^0 + y^0$
3

g $(2x)^0 - z^0$
0

h $2p \times 3q^0$
$6p$

6 Simplify these expressions.

a $(-x)^0$
1

b $-x^0$
-1

c $w^0 - x^0$
0

d $s^0 - (-x)^0$
0

e $w^0 + (-x)^0$
2

f $(-w)^0 + (-x)^0$
2

g $-w^0 + (-x)^0$
0

h $-w^0 - x^0$
-2

MIXED PRACTICE

Index Law of Multiplication	Index Law of Division
$a^m \times a^n = a^{m+n}$	$\frac{a^m}{a^n} = a^{m-n}$

Power of a Power	Index Law of Zero
$(a^m)^n = a^{m \times n}$	$a^0 = 1$

FOUNDATION

1 Find the missing numbers.

a $6^5 \times 6^7 = 6^{\square + \square} = 6^{\square}$ 6^{12}

b $a^{13} \times a^2 = a^{\square + \square} = a^{\square}$ a^{15}

c $5^{12} \div 5^4 = 5^{\square - \square} = 5^{\square}$ 5^8

d $\frac{m^{16}}{m^2} = m^{\square - \square} = m^{\square}$ m^{14}

2 Simplify these expressions using the index laws.

a $x^4 \times x^3$ x^7

b $a^6 \times a^3$ a^9

c $t^5 \times t^3$ t^8

d $a^6 \div a^4$ a^2

e $x^5 \div x^2$ x^3

f $\frac{q^{12}}{q^2}$ q^{10}

g $(x^3)^5$ x^{15}

h $(x^7)^3$ x^{21}

i x^0 1

j $y \times y^4$ y^5

k $d^2 \times d$ d^3

l $\frac{d^7}{d^6}$ d

m $(y^7)^0$ 1

n $2x^0$ 2

o $\frac{e^5}{e^0}$ e^5

p $y^2 \times y \times y^4$ y^7

q $b \times b^5 \times b^2$ b^8

r $\frac{8b^{10}}{4b^5}$ $2b^5$

s $\frac{12d^{10}}{36d^5}$ $\frac{d^5}{3}$

t $q^6 \times q^3 \times q^2$ q^{11}

u $\frac{4a^{14}}{2a^7}$ $2a^7$

v $\frac{18y^{15}}{9y^7}$ $2y^8$

w $\frac{9y^7}{18y^{15}}$ $\frac{1}{2y^8}$

x $9m^3 \div m^2$ $9m$

y $5y^4 \div y^2$ $5y^2$

z $\frac{3m^7}{12m^2}$ $\frac{m^4}{4}$

aa $\frac{4a^4}{20a^3}$ $\frac{a}{5}$

3 Simplify the following.

a	$(y^6)^2$	**b**	$(m^3)^6$	**c**	$(x^2)^5$
	y^{12}		m^{18}		x^{10}
d	5^0	**e**	$(-6)^0$	**f**	$5(m^8)^2$
	1		1		$5m^{16}$
g	$4(q^7)^4$	**h**	$(-3)^0$	**i**	$-(4)^0$
	$4q^{28}$		1		-1
j	$-3(c^2)^5$	**k**	$2(j^4)^6$	**l**	$-3p^0$
	$-3c^{10}$		$2j^{24}$		-3
m	$(0.75)^0$	**n**	$\left(\frac{3}{4}\right)^0$	**o**	$(4y)^0$
	1		1		1
p	$5m^0$	**q**	$-3p^0$	**r**	$6x^0 - 2x^0$
	5		-3		4
s	$-5n^0 - (8n)^0$	**t**	$(3x^4)^0$	**u**	$1^0 + 2^0 + 3^0$
	-6		1		3
v	$(1 + 2 + 3)^0$	**w**	$100^0 - a^0$	**x**	$(-5)^0$
	1		0		1

4 Simplify each of the following by combining various index laws

a	$4 \times (4^3)^2$	**b**	$(3^4)^2 \times 3$	**c**	$x \times (x^0)^5$
	4^7		3^9		x
d	$7^8 \div (7^3)^2$	**e**	$(4^2)^3 \div 4^5$	**f**	$(3^6)^3 \div (3^5)^2$
	7^2		4		3^8
g	$y^5 \times (y^2)^4$	**h**	$b^5 \times (b^3)^3$	**i**	$(a^2)^3 \times a^4$
	y^{13}		b^{14}		a^{10}
j	$(m^3)^6 \div (m^2)^9$	**k**	$(y^5)^3 \div (y^6)^2$	**l**	$(h^{11})^2 \div (h^5)^4$
	1		y^3		h^2
m	$a^3f \times (a^4)^2 \times (f^4)^3$	**n**	$x^2y \times (x^3)^4 \times (y^2)^2$	**o**	$(s^2)^3 \times 5(r^0)^3 \times rs^2$
	$a^{11}f^{13}$		$x^{14}y^5$		$5rs^8$

5 Simplify these expressions.

a $\frac{a^5 \times a^4}{a^6} = \frac{\square}{\square} = \square$ a^3

b $\frac{n^3}{n^7 \times n^2} = \frac{\square}{\square} = \frac{\square}{\square}$ $\frac{1}{n^6}$

c $\frac{g^5}{g^2 \times g^4} = \frac{\square}{\square} = \frac{\square}{\square}$ $\frac{1}{g}$

d $\frac{p^5}{p^3 \times p^4} = \frac{\square}{\square} = \frac{\square}{\square}$ $\frac{1}{p^2}$

e $\frac{d^3 \times d^5}{d \times d^4} = \frac{\square}{\square} = \square$ d^3

f $\frac{c^5 \times c^4}{c^3 \times c^2} = \frac{\square}{\square} = \square$ c^4

g $\frac{ab \times b^2}{a^2 \times a^3}$ $\frac{b^3}{a^4}$

h $\frac{mx^5 \times m^2}{m^4 \times xm}$ $\frac{x^4}{m^2}$

i $\frac{xy^5 \times y^2}{x^4 \times x^2y}$ $\frac{y^6}{x^5}$

j $\frac{cn^3 \times cn^2}{c^2 \times cn^2}$ $\frac{n^3}{c}$

k $\frac{ac^3 \times a^2}{a^3c^4 \times c^2}$ $\frac{1}{c^3}$

l $\frac{w^2n^5 \times w^2}{nw \times w^3}$ n^4

m $\frac{k^2y \times y^2k^4}{y^3 \times y^2k^4}$ $\frac{k^2}{y^2}$

n $\frac{q^3n^2 \times n^4}{qn^6 \times n^4q^3}$ $\frac{1}{qn^4}$

o $\frac{b^2d^3 \times b^2d}{bd^2 \times b^2d^2}$ b

6 Simplify these expressions.

a $\frac{x^3 \times x^6}{x^4}$ x^5

b $\frac{y^3 \times y^2}{y^2}$ y^3

c $\frac{4^5 \times 4^3}{4^2}$ 4^6

d $\frac{a^5 \times a^2}{a}$ a^6

e $\frac{p^2 \times p^3}{p^7}$ $\frac{1}{p^2}$

f $\frac{t^2}{t^4 \times t^2}$ $\frac{1}{t^4}$

g $\frac{3^4 \times 3^2 \times 3^2}{3^4}$ 3^4

h $\frac{y^4 \times y^3}{y^2 \times y}$ y^4

i $\frac{2^2 \times 2^3 \times 2^2}{2^7 \times 2^3}$ $\frac{1}{2^3}$

7 Find the missing numbers.

a $2^7 \times 2^{\square} = 2^{19}$ — 12

b $6^{\square} \times 6^3 = 6^{11}$ — 8

c $11^6 \div 11^{\square} = 11^3$ — 3

d $19^{\square} \div 19^2 = 19$ — 3

e $x^6 \times x^{\square} = x^7$ — 1

f $a^{\square} \times a^2 = a^{20}$ — 18

g $b^{13} \div b^{\square} = b$ — 12

h $y^{\square} \div y^9 = y^2$ — 11

i $\square \times x^2 \times 3x^4 = 12x^6$ — 4

j $15y^4 \div (\square y^3) = y$ — 15

k $\square a^9 \div (4a) = \frac{a^8}{2}$ — 2

l $13b^6 \div (\square b^5) = \frac{b}{3}$ — 39

8 Simplify

a $5 \times (5^5)^5$ — 5^{26}

b $(m^2)^5 \times m^4$ — m^{14}

c $(x^3 \times x^4)^2$ — x^{14}

d $(n^3)^7 \div n^5$ — n^{16}

e $(m^3)^5 \times (m^4)^2$ — m^{23}

f $\frac{g^{10}}{(g^2)^3}$ — g^4

9 These simplifications are not correct. Provide the correct answer.

a $a^4 \times a = a^4$ ✗ — a^5

b $x^7 \div x = x^7$ ✗ — x^6

c $3a^5 \div 6a^3 = 2a^2$ ✗ — $\frac{a^2}{2}$

d $5x^7 \div 10x^3 = \frac{1}{2x^4}$ ✗ — $\frac{x^4}{2}$

e $2x^7 \times 3x^4 = 5x^{11}$ ✗ — $6x^{11}$

f $a^5 \div a^2 \times a = a^5 \div a^3$ ✗ — a^4

g $(a^4)^5 = a^9$ ✗ — a^{20}

h $3(x^3)^2 = 9x^6$ ✗ — $3x^6$

i $(-2x)^0 = -2$ ✗ — 1

10 Match the cards.

a	$g^3(g^2 + g^5)$	**A**	g^{10}
b	$g^3(g^2 \times g^5)$	**B**	g^{21}
c	$(g^2)^3 + (g^5)^3$	**C**	$g^5 + g^8$
d	$(g^2)^3 \times (g^5)^3$	**D**	$g^6 + g^{15}$

a – C, b – A, c – D, d – B

11 Simplify these expressions.

a $\frac{a^3 \times a^5}{a^6}$

a^2

b $\frac{a^6}{a^3 \times a^5}$

$\frac{1}{a^2}$

c $\frac{x^6}{a^3 \times a^5}$

$\frac{x^6}{a^8}$

d $\frac{12x^6}{2a^3 \times 3a^5}$

$\frac{2x^6}{a^8}$

e $\frac{12x^6}{2x^3 \times 3x^5}$

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

f $2x^3 \times 3x^5$

$6x^8$

g $2x^3y^2 \times 3x^5y^2$

$6x^8y^4$

h $12x^6y^2 \times 3x^5y^2$

$36x^{11}y^4$

i $12x^6y^2 \div 3x^5y^2$

$4x$

j $\frac{12x^6y^8}{3x^5y^2}$

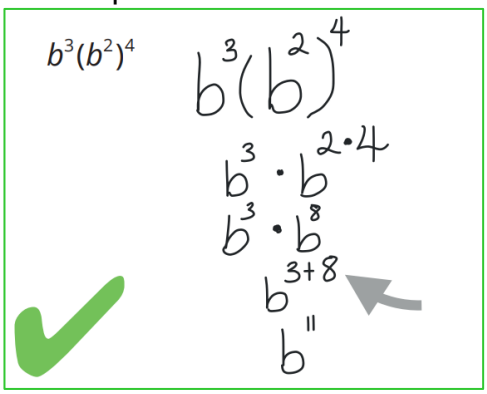
$4xy^6$

12 Read the example carefully and answer the questions.

Liz's work

Write as an expression without brackets:

$b^3(b^2)^4$



In the step marked with an arrow, why did Liz add instead of multiply?

Index law of multiplication says to add

Simplify

$(r^5)^2r^3$

r^{13}

13 Look at the example and then answer the questions.

$$\frac{v^4x^5 \times 5v^3}{4vx^3 \times 3xv} = \frac{5v^7x^5}{12v^2x^4} = \frac{5v^5x}{12}$$

a $\dfrac{3h^2c \times 3h^4}{2h^3 \times c^3} = \dfrac{\square}{\square} = \dfrac{\square}{\square}$ $\frac{9h^3}{2c^2}$

b $\dfrac{5a^2y^2 \times 2y^4}{7y^4 \times a^3} = \dfrac{\square}{\square} = \dfrac{\square}{\square}$ $\frac{10y^2}{7a}$

c $\dfrac{2j^2k \times 4k^2}{3j^4}$ $\frac{8k^3}{3j^2}$

14 Simplify the following using index laws.

a $b^5 \times b^2 \div b$ b^6

b $y^5 \times y^4 \div y^3$ y^6

c $c^4 \div c \times c^4$ c^7

d $x^4 \times x^2 \times x^5$ x^{11}

e $\dfrac{t^4 \times t^3}{t^6}$ t

f $\dfrac{p^2 \times p^7}{p^3}$ p^6

g $\dfrac{d^5 \times d^3}{d^2}$ d^6

h $\dfrac{x^9 \times x^2}{x}$ x^{10}

i $\dfrac{3x^3y^4 \times 8xy}{6x^2y^2}$ $4x^2y^3$

j $\dfrac{9b^4}{2g^3} \times \dfrac{4g^4}{3b^2}$ $6b^2g$

k $\dfrac{24m^7n^5}{5m^3n} \times \dfrac{5m^2n^4}{8mn^2}$ $3m^5n^6$

l $\dfrac{p^4q^3}{p^2q} \times \dfrac{p^6q^4}{p^3q^2}$ p^5q^4

15 Look at the example and then answer the questions.

$$\frac{3v^4x^5 \times v^3}{2vx^3 \times 6xv} = \frac{3v^7x^5}{12v^2x^4} = \frac{v^5x}{4}$$

a $\dfrac{3ve^3 \times 5e}{2e^3v^5}$ $\frac{15e}{2v^4}$

b $\dfrac{2n^2w \times 6n^4}{3n^3}$ $4n^3w$

c $\dfrac{2x^2y^3 \times 5y^4}{10x \times 2y^3}$ $\frac{xy^4}{2}$

d $\dfrac{5m^2e^3 \times m^2}{2m^4 \times e^4m}$ $\frac{5}{2me}$

e $\dfrac{6h^2q \times 3q^2}{2hq^4 \times h^2q^2}$ $\frac{9}{hq^3}$

f $\dfrac{5y^2x^5 \times 4y^2}{y^4x^3 \times 10x^2}$ 2

16 Find the missing numbers.

a $3^{\square} = 81$ — 4

b $2^{\square} = 256$ — 8

c $\square^3 = 125$ — 5

d $\square^5 = 32$ — 2

e $\square^3 = -64$ — -4

f $\square^7 = -128$ — -2

g $\square^3 = \frac{1}{8}$ — $\frac{1}{2}$

h $\left(\frac{2}{3}\right)^{\square} = \frac{16}{81}$ — 4

17 Write each of the following in index form.

a $\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$ — $\left(\frac{2}{3}\right)^4$

b $\frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5}$ — $\left(\frac{3}{5}\right)^5$

c $\frac{4}{7} \times \frac{4}{7} \times \frac{1}{5} \times \frac{1}{5} \times \frac{1}{5} \times \frac{1}{5}$ — $\left(\frac{4}{7}\right)^2 \left(\frac{1}{5}\right)^4$

d $\frac{7x}{9} \times \frac{7x}{9} \times \frac{y}{4} \times \frac{y}{4} \times \frac{y}{4}$ — $\left(\frac{7x}{9}\right)^2 \left(\frac{y}{4}\right)^3$

18

a Simplify

$4y^3 \times 2y^8$

$8y^{11}$

b Work out the value of

$(4 \times 10^3) \times (2 \times 10^8)$

8×10^{11}

c Simplify

$\frac{4y^3}{2y^8}$

$\frac{2}{y^5}$

d Work out the value of

$\frac{4 \times 10^3}{2 \times 10^8}$

$\frac{2}{10^5}$

19

a Simplify

$\frac{9y^4}{3y^7}$

$\frac{3}{y^3}$

b Simplify

$9y^4 \times 3y^7$

$27y^{11}$

e Work out the value of

$(9 \times 10^4) \times (3 \times 10^7)$

27×10^{11}

c Simplify

$\frac{9 \times 10^4}{3 \times 10^7}$

$\frac{3}{10^3}$

20 NAPLAN B

Simplify the expression $\frac{(12x)^0}{4} \times \frac{5x}{3}$

$\frac{5x}{12}$

21 NAPLAN B

Simplify the expression $\frac{20m^0}{n} \times \frac{n^2}{5m}$

$\frac{4n}{m}$

22 Find the missing terms.

a $\frac{2c^3}{\square} = 2c$ — c^2

b $\frac{w^4}{\square} = \frac{w^3}{m}$ — wm

c $\frac{\square}{3a} = 4$ — $12a$

d $\frac{4e^5}{\square} = \frac{e^3}{2}$ — $8e^2$

e $\square \div 2k = 3k$ — $6k^2$

f $6a^2b \div \square = 3ab$ — $2a$

g $\square \div y = \frac{3x}{y}$ — $3x$

h $\frac{\square}{2j^3} = \frac{7}{j}$ — $14j^2$

i $\frac{5ux}{\square} = \frac{1}{2w}$ — $10uxw$

j $\square \div 4v^2y = \frac{-5y^3}{2v}$ — $-20vy^4$

k $\frac{\square}{-2hg^3} = \frac{h}{g}$ — $-2h^2g^2$

l $16x^3k \div \square = \frac{-8}{3x}$ — $-6x^4k$

m $\square \div 2y^2 = 9x$ — $18xy^2$

n $\frac{-8ka^3}{\square} = \frac{2k}{a^3}$ — $-4a^6$

o $\square \div 4ey^4 = \frac{-1}{y^2}$ — $-4ey^2$

23

a Simplify

$$\frac{(a^3)^2 \times a^4}{(a^2)^5}$$

1

b Does the value of a matter?

no

24 Simplify the following.

a $\frac{3a^5bc^3}{6a^4c} \times \frac{4b^3}{2abc} \times \frac{2a^3b^2c}{2a^2b^4c^2}$ — ab

b $\frac{3a^4b^5}{a^5b^2} \div \frac{6b^3}{2a^2b}$ — ab

c $\frac{2a}{3a^2b^3} \times \frac{9a^4b^7}{ab^5} \div \frac{6a}{b^2}$ — ab

25 Expand:

a $6a^2(2a - 4a^3)$ — $12a^3 - 24a^5$

b $c^{\frac{3}{2}}\left(c^{\frac{1}{2}} + c^{-\frac{3}{2}}\right)$ — $c^2 + 1$

c $-6a^2b^3c(2a^3b + a^2bc^{-1})$ — $-12a^5b^4c - 6a^4b^4$

26 Evaluate without a calculator.

a $(2^4)^8 \div 2^{30}$

4

b $(10^3)^7 \div 10^{18}$

1000

c $(7^4)^9 \div 7^{36}$

1

d $((-1)^{11})^2 \div ((-1)^2)^{11}$

1

e $-2((-2)^3)^3 \div (-2)^8$

4

f $\dfrac{(5^2)^3}{(8^4)^7} \times \dfrac{(8^7)^4}{(5^3)^2}$

1

27 Split these expressions according to prime factors.

a 6^n

$= (2 \times 3)^n$

$= 2^n \times 3^n$

b 21^y

$3^y \times 7^y$

c 12^x

$2^{2x} \times 3^x$

d 10^{x+y}

$2^{x+y} \times 5^{x+y}$

e 35^{2x+3}

$5^{2x+3} \times 7^{2x+3}$

f 26^{4x-3z}

$2^{4x-3z} \times 13^{4x-3z}$

28 Simplify each of the following by combining various index laws

a $\dfrac{(b^2)^5}{b^4}$

b^6

b $\dfrac{(x^4)^3}{x^7}$

x^5

c $\dfrac{(y^3)^3}{y^3}$

y^6

d $\dfrac{3x^4 \times 6x^3}{9x^{12}}$

$\dfrac{2}{x^5}$

e $\dfrac{5x^5 \times 4x^2}{2x^{10}}$

$\dfrac{10}{x^3}$

f $\dfrac{24(x^4)^4}{8(x^4)^2}$

$3x^8$

g $\dfrac{4(d^4)^3 \times (e^4)^2}{8(d^2)^5 \times e^7}$

$\dfrac{d^2e}{2}$

h $\dfrac{6(m^3)^2(n^5)^3}{15(m^5)^0(n^2)^7}$

$\dfrac{2m^6n}{5}$

i $\dfrac{2(a^3)^4(b^2)^6}{16(a)^0(b^6)^2}$

$\dfrac{a^{12}}{8}$

29 Simplify $\dfrac{5ab^2}{2ab^2} \div \dfrac{10a^4b^7}{4a^3b^8}$

$\dfrac{b}{a}$

30 Given that $\frac{y^n \times y^5}{y^6} = y^{13}$, work out the value of n.

14

31 Solve to find x

$$\left(m^{\frac{3}{11}}\right)^x = m^{\frac{5}{9}}$$

$\frac{55}{27}$

32 Find the value of n

$$\frac{(x^{-6})^5}{x^4} = x^n$$

-34

33 Simplify

$$\frac{3x^{-\frac{5}{4}} \times 4x^{\frac{7}{4}}}{x^{\frac{3}{2}}}$$

$\frac{12}{x}$ or $12x^{-1}$

34 Solve $3^x \times 3^{x+3} = 81$

$x = 0.5$

CHECK YOUR UNDERSTANDING

Index law of multiplication

a Simplify $z^6 \times z^3$

a z^{18} **b** $2z^9$ **c** z^9 **d** Can't simplify

b Simplify $m^2 \times m^3$

a m^5 **b** $2m^5$ **c** m^6 **d** Can't simplify

c Simplify $w^4 + w^4$

a $2w^4$ **b** w^8 **c** w^{16} **d** $8w$

d Simplify $5p^2 \times 2p$

a $10p^3$ **b** $7p^3$ **c** $10p^2$ **d** Can't simplify

e Simplify $5p^2 \times 2pq$

a $10pq^3$ **b** $10p^3q$ **c** $7p^3q$ **d** Can't simplify

f Simplify $3x^3y^2 \times 4xy^4$

a $3x^3y^7$ **b** $12x^3y^8$ **c** $7x^4y^6$ **d** $12x^4y^6$

g Simplify $4x^3y^2 \times 2xy^5$

a $8x^4y^7$ **b** $4x^4y^7$ **c** $8x^3y^{10}$ **d** $6x^4y^7$

Index law of division

1 Simplify $m^8 \div m^4$

a m^4 **b** m^2 **c** 2 **d** $2m$

2 Simplify $m^8 \div m^2$

a $4m$ **b** m^6 **c** m^4 **d** 4

3 Simplify $20^6 \div 4^3$

a 5^3 **b** 5^2 **c** 16^3 **d** Can't simplify

4 Simplify $\frac{m^5 \times m^2}{m}$

a m^{10} **b** m^9 **c** m^8 **d** m^6

5 Simplify $6p^6 \div 2p^2$

a $4p^4$ **b** $3p^4$ **c** $3p^3$ **d** Can't simplify.

Index law of power of a power and zero

1 $(2^3)^4$

a 2^{12} **b** 2^7 **c** 6^4 **d** None of these

2 $(6^2)^3$

a 6^5 **b** 6^6 **c** 12^3 **d** 36^3

3 $(c^4)^2$

a $8c$ **b** $2c^4$ **c** c^6 **d** c^8

4 7^0

a 70 **b** 1 **c** 0 **d** 7

5 $(4 \times 4)^0$

a 16 **b** 0 **c** 1 **d** 4

6 $4^0 \times 4$

a $\frac{1}{4}$ **b** 0 **c** 1 **d** 4

7 5×3^0

a 15^0 **b** 1 **c** 3 **d** 5

8 $x^0 \times x$

a $\frac{1}{x}$ **b** 0 **c** 1 **d** x

9 $\frac{x^5}{x^2 \times x^3}$

a 1 **b** x **c** x^{-1} **d** x^{11}