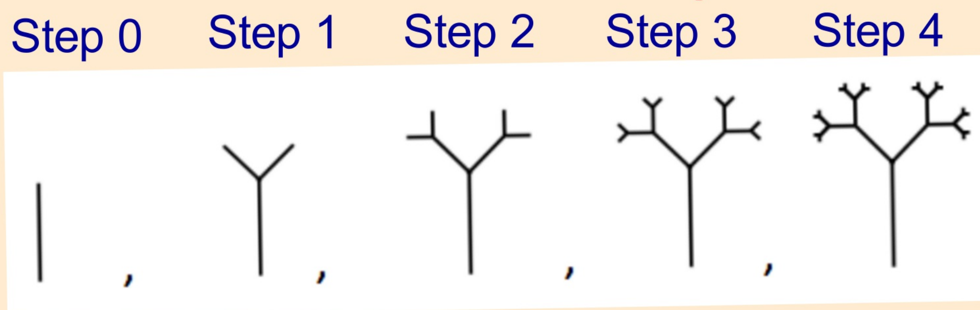
Welcome Back MYP Math 9!

	Assignment Effort Grade (Circle One)	Comments (What was interesting or challenging?)
Monday Date: 1/29 Topic:__________	**0 1 2**	I rested after FINALS :)
Tuesday Date: 1/30 Topic:__________	**0 1 2**	New Semester!
Wednesday Date: _____ Topic:__________	**0 1 2**	
Thursday Date: _____ Topic:__________	**0 1 2**	
Friday Date: _____ Topic:__________	**0 1 2**	

Class Plan:

1. Warm-up
2. Introduce Unit 5: Indices (Exponentials) and Logarithms
   Consider questions to be answered
3. Laws of Indices (Exponents) Investigation
4. Practice

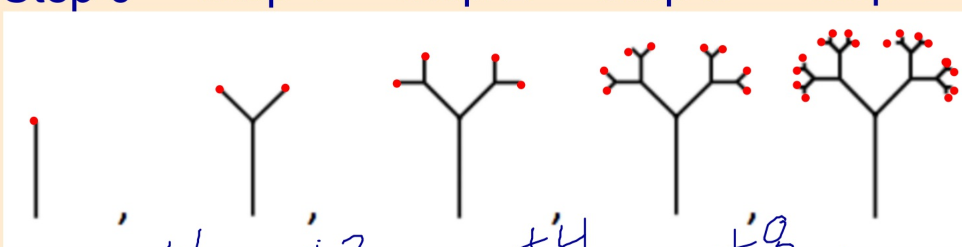
Warm-up: What's the pattern?



Warm-up: What's the pattern?

How many *endpoints* are there at each step?

Step 0 Step 1 Step 2 Step 3 Step 4

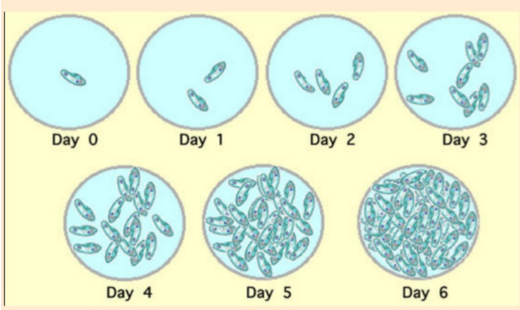


1 +1 2 +2 4 +4 8 +8 16

x2 x2 x2 x2

Unit 5: Exponentials (or Indices)

What are some applications of exponents?



People who use Exponents:

Economists, Bankers, Financial Advisors, Insurance Risk Assessors, Biologists, Engineers, Computer Programmers, Chemists, Physicists, Geographers, Sound Engineers, Statisticians, Mathematicians, Geologists and many other professions

http://passyworldofmathematics.com/exponents-in-the-real-world/

Unit 5: Exponentials and Logarithms

Questions to be answered in the unit:

- What is an exponent?
- What is the base?
- What is a logarithm?
- How are the two related?
- How can I use one to solve the other?

Unit 5: Exponentials and Logarithms

What do exponents allow us to do?

Find the integer equal to: **a** 2^5 **b** $2^3 \times 5^2 \times 7$

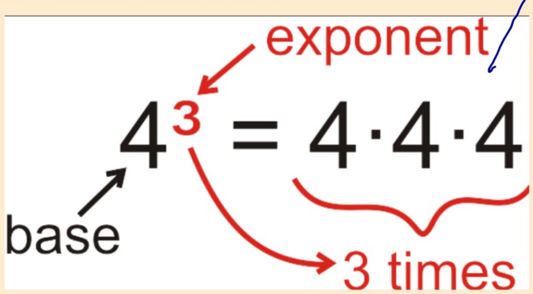
Indices or Exponents are used to show repeated multiplication.

Simplify using index notation:

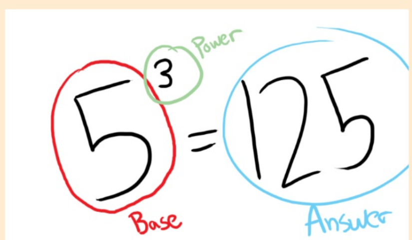
a $p \times p \times p \times p \times 3$ **b** $5 \times z \times z \times z \times y + y \times y$

Unit 5: Exponentials and Logarithms

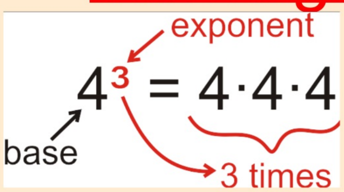
- What is an exponent?
- What is the base?



/INDEX/POWER



<u>Investigation</u>:Index Laws



(Calculator may help as well)

<--- Use expanded form to discover the laws/properties.

Do not MEMORIZE....Understand the relationships!

(Properties of Exponents)

$b^m \cdot b^n = b^{\square}$

$b^0 = \square$

$\frac{1}{b^m} = \square$

$(b^m)^n = b^{\square}$

$\frac{b^m}{b^n} = b^{\square}$

$b^{-m} = \frac{\square}{\square}$

When done: Help others!

Property Investigation

Original	=	Expanded Form	=	Simplified, one base (Exponential Form)
$x^2 \cdot x^4$	$=$	$x \cdot x \cdot x \cdot x \cdot x \cdot x$	$=$	x^6

1. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

a) $5^3 \cdot 5^4 =$ $5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5$ $= 5^{\boxed{7}}$

b) $a^2 \cdot a^3 =$ ____________________________ $= a^{\boxed{}}$

2. Examine the simplified form and the exponents in parts **a - b.**

   i. What **<u>operation</u>** did you do with the exponents to simplify your expression?

   ii. Write a rule for simplifying exponents when we multiply terms with the same base:

$$b^m \cdot b^n = b^{\boxed{}}$$

Answers to Investigation

Original = Expanded Form = Simplified, one base **(Exponential Form)**

$$x^2 \cdot x^4 = x \cdot x \cdot x \cdot x \cdot x \cdot x = x^6$$

1. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

a) $5^3 \cdot 5^4 = 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 5^{7}$

b) $a^2 \cdot a^3 = a \cdot a \cdot a \cdot a \cdot a = a^{5}$

2. Examine the simplified form and the exponents in parts **a - b.**

i. What operation did you do with the exponents to simplify your expression?

ADD

ii. Write a rule for simplifying exponents when we multiply terms with the same base:

$$b^m \cdot b^n = b^{m+n}$$

Property Investigation

Original = Expanded Form = Simplified, one base (Exponential Form)

$$(x^3)^4 = (x^3)(x^3)(x^3)(x^3) = x^{12}$$

3. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

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

b) $(xy^6)^2 =$ $(xyyyyyy)(xyyyyyy)$ $= x^{\square}y^{\square}$

c) $(2w^5)^5 =$ ____________________ = __________

4. Examine the simplified form and the exponents in parts **a - c.**

   i. What operation did you do with the exponents to simplify your expression?

   ii. Write a rule for simplifying exponents when a base is raised by more than one exponent:

$$(b^m)^n = b^{\square}$$

Answers to Investigation

Original =	Expanded Form	= Simplified, one base (Exponential Form)
$(x^3)^4$ =	$(x^3)(x^3)(x^3)(x^3)$	$= x^{12}$

3. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

a) $(3^2)^4 = (3^2)(3^2)(3^2)(3^2) = 3^{\boxed{8}}$

b) $(xy^6)^2 = (xy^6)(xy^6) = x \cdot x \cdot y \cdot y \cdot y \cdot y \cdots = x^{\boxed{2}}y^{\boxed{12}}$

c) $(2w^5)^5 = (2w^5)(2w^5)(2w^5)(2w^5)(2w^5) = 32w^{25}$

2^5

4. Examine the simplified form and the exponents in parts **a - c.**

i. What operation did you do with the exponents to simplify your expression?

multiply

ii. Write a rule for simplifying exponents when a base is raised by more than one exponent:

$$(b^m)^n = b^{\boxed{m \cdot n}}$$

Property Investigation

5. Rewrite in expanded form. Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{3^5}{3^1} = \underline{\hspace{6cm}} = 3^{\square}$ b) $\frac{y^7}{y^2} = \underline{\hspace{6cm}} = y^{\square}$

6. Examine the simplified form and the exponents in parts **a – b** from #5.

i. What operation did you do with the exponents to simplify your expression?

ii. Write a rule for simplifying exponents when we are dividing terms with the same base:

$$\frac{b^m}{b^n} = b^{\square}$$

Answers to Investigation

5. Rewrite in expanded form. Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{3^5}{3^1} = \frac{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3}{3} = 3^{4}$

b) $\frac{y^7}{y^2} = \frac{y \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y}{y \cdot y} = y^{5}$

6. Examine the simplified form and the exponents in parts **a – b** from #5.

i. What operation did you do with the exponents to simplify your expression?

Subtract

ii. Write a rule for simplifying exponents when we are dividing terms with the same base:

$$\frac{b^m}{b^n} = b^{m-n}$$

m − n

Property Investigation

Original = expanded form = Simplified Exonential form

$$\frac{x^3}{x^3} = \frac{x \cdot x \cdot x}{x \cdot x \cdot x} = x^{\boxed{0}} = ?$$

7. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{4^3}{4^3} = \_\_\_\_\_\_\_\_\_\_\_\_ = 4^{\square} =$ **b)** $\frac{x^2}{x^2} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ = x^{\square} =$

8. Examine the simplified form and the exponents in parts **a** and **b** of #7.

i. Write a rule for the exponent of ***zero.***

$$b^0 = \square$$

Answers to Investigation

Original = expanded form = Simplified Exonential form

$$1 = \frac{x^3}{x^3} = \frac{x \cdot x \cdot x}{x \cdot x \cdot x} = x^{\boxed{0}} = ? \quad x^{3-3} = x^0$$

7. Rewrite each expression in expanded form (***shown above***). Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{4^3}{4^3} = \frac{4 \cdot 4 \cdot 4}{4 \cdot 4 \cdot 4} = 4^{\boxed{0}} = 1$

b) $\frac{x^2}{x^2} = \frac{x \cdot x}{x \cdot x} = x^{\boxed{0}} = 1$

8. Examine the simplified form and the exponents in parts **a** and **b** from #7.

i. Write a rule for the exponent of **zero.**

$$b^0 = \boxed{1}$$

Property Investigation

9. Rewrite in expanded form. Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{3^2}{3^5} = \underline{\hspace{8cm}} = \frac{1}{3^{\square}} = 3^{\square}$

b) $\frac{r}{r^3} = \underline{\hspace{8cm}} = \frac{1}{r^{\square}} = r^{\square}$

10. Examine the simplified form and the exponents in parts **a** and **b** from #9.

i. Write a rule for simplifying **negative exponents.**

$b^{-m} = \boxed{\frac{}{}}$ **AND** $\frac{1}{b^m} = \boxed{}$

Answers to Investigation

9. Rewrite in expanded form. Then rewrite it in ***simplified*** exponential form with a single base.

a) $\frac{3^2}{3^5} = \frac{3 \cdot 3}{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3} = \frac{1}{3^{3}} = 3^{-3}$

b) $\frac{r}{r^3} = \frac{r}{r \cdot r \cdot r} = \frac{1}{r^{2}} = r^{-2}$

10. Examine the simplified form and the exponents in parts **a** and **b** from 9.

i. Write a rule for the **negative property of exponents.**

$b^{-m} = \frac{1}{b^m}$ **AND** $\frac{1}{b^m} = b^{-m}$

B Chapter 2 INDEX LAWS

If the bases a and b are both positive, and the indices m and n are integers, then:

$a^m \times a^n = a^{m+n}$	To **multiply** numbers with the **same base**, keep the base and **add** the indices.
$\dfrac{a^m}{a^n} = a^{m-n}$	To **divide** numbers with the same base, keep the base and **subtract** the indices.
$(a^m)^n = a^{mn}$	When **raising** a **power** to a **power**, keep the base and **multiply** the indices.
$(ab)^n = a^n b^n$	The power of a product is the product of the powers.
$\left(\dfrac{a}{b}\right)^n = \dfrac{a^n}{b^n}$	The power of a quotient is the quotient of the powers.
$a^0 = 1, \quad a \neq 0$	Any non-zero number raised to the power of zero is 1.

$a^{-n} = \dfrac{1}{a^n}$ and in particular $a^{-1} = \dfrac{1}{a}$.

B Chapter 2 INDEX LAWS

Product Property of Exponents

$$a^m \cdot a^n = a^{m+n}$$

Quotient Property of Exponents

$$\frac{a^m}{a^n} = a^{m-n}$$

Definition of Negative Exponents

$$a^{-n} = \frac{1}{a^n} \quad \text{or} \quad \left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$$

Zero Exponents

$$a^0 = 1$$

Power of a Power Property

$$(a^m)^n = a^{mn}$$

Power of a Product Property

$$(ab)^m = a^m b^m$$

Power of a Quotient Property

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

***<u>Important:</u> Recognize how connected the properties are.

B EXAMPLES — INDEX LAWS

a $11^5 \times 11^3$ $= 11^8$

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

c $\dfrac{b^3 \times b^7}{(b^2)^4}$ $= \dfrac{b^{10}}{b^8} = b^2$

B EXAMPLES **INDEX LAWS**

a $(3a^3b)^4$ $= 3^4 a^{12} b^4 = 81a^{12}b^4$

$(3a^3b)(3a^3b)(3a^3b)(3a^3b)$

b $5^0 - 5^{-1}$ $= 1 - \frac{1}{5} = \frac{5}{5} - \frac{1}{5} = \frac{4}{5}$

c $\left(\frac{2}{5}\right)^{-2}$ $= \left(\frac{5}{2}\right)^2 = \frac{25}{4}$

B EXAMPLES — INDEX LAWS

Example 5 — Self Tutor

Simplify using $a^m \times a^n = a^{m+n}$:

a $11^5 \times 11^3$ **b** $a^4 \times a^5$ **c** $x^4 \times x^a$

a
$$11^5 \times 11^3 = 11^{5+3} = 11^8$$

b
$$a^4 \times a^5 = a^{4+5} = a^9$$

c
$$x^4 \times x^a = x^{4+a} = x^{a+4}$$

Example 6 — Self Tutor

Simplify using $\frac{a^m}{a^n} = a^{m-n}$: **a** $\frac{7^8}{7^5}$ **b** $\frac{b^6}{b^m}$

a
$$\frac{7^8}{7^5} = 7^{8-5} = 7^3$$

b
$$\frac{b^6}{b^m} = b^{6-m}$$

B EXAMPLES — INDEX LAWS

Example 7 — Self Tutor

Simplify using $(a^m)^n = a^{mn}$:

a $(2^4)^3$ **b** $(x^3)^5$ **c** $(b^7)^m$

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

b $(x^3)^5$
$= x^{3\times 5}$
$= x^{15}$

c $(b^7)^m$
$= b^{7\times m}$
$= b^{7m}$

Example 8 — Self Tutor

Simplify:

a 7^0 **b** x^0 **c** $\frac{y^4}{y^4}$ **d** $2 + 5^0$

a $7^0 = 1$

b $x^0 = 1$ {provided $x \neq 0$}

c $\frac{y^4}{y^4} = y^{4-4}$
$= y^0$
$= 1$ {provided $y \neq 0$}

d $2 + 5^0$
$= 2 + 1$
$= 3$

B EXAMPLES — INDEX LAWS

Example 9 — Self Tutor

Simplify using the index laws:

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

b $\dfrac{20a^9}{4a^6}$

c $\dfrac{b^3 \times b^7}{(b^2)^4}$

a
$$\begin{aligned} & 3x^2 \times 5x^5 \\ &= 3 \times 5 \times x^2 \times x^5 \\ &= 15 \times x^{2+5} \\ &= 15x^7 \end{aligned}$$

b
$$\begin{aligned} \frac{20a^9}{4a^6} &= \frac{20}{4} \times a^{9-6} \\ &= 5a^3 \end{aligned}$$

c
$$\begin{aligned} \frac{b^3 \times b^7}{(b^2)^4} &= \frac{b^{3+7}}{b^{2\times 4}} \\ &= \frac{b^{10}}{b^8} \\ &= b^{10-8} \\ &= b^2 \end{aligned}$$

B EXAMPLES — INDEX LAWS

Example 10 — Self Tutor

Express in simplest form with a prime number base:

a 4^4 **b** 9×3^a **c** 49^{x+2}

a 4^4
$= (2^2)^4$
$= 2^{2\times 4}$
$= 2^8$

b 9×3^a
$= 3^2 \times 3^a$
$= 3^{2+a}$
$= 3^{a+2}$

c 49^{x+2}
$= (7^2)^{x+2}$
$= 7^{2(x+2)}$

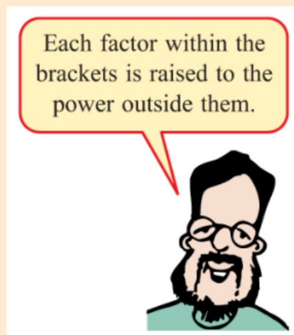
Example 11 — Self Tutor

Remove the brackets of:

a $(3a)^2$ **b** $\left(\frac{2x}{y}\right)^3$

a $(3a)^2 = 3^2 \times a^2$
$= 9a^2$

b $\left(\frac{2x}{y}\right)^3 = \frac{2^3 \times x^3}{y^3}$
$= \frac{8x^3}{y^3}$



B EXAMPLES — INDEX LAWS

Example 12 — Self Tutor

Express in simplest form, without brackets: **a** $(3a^3b)^4$ **b** $\left(\dfrac{x^2}{2y}\right)^3$

a $(3a^3b)^4$

$= 3^4 \times (a^3)^4 \times b^4$

$= 81 \times a^{3\times 4} \times b^4$

$= 81a^{12}b^4$

b $\left(\dfrac{x^2}{2y}\right)^3 = \dfrac{(x^2)^3}{2^3 \times y^3}$

$= \dfrac{x^{2\times 3}}{8 \times y^3}$

$= \dfrac{x^6}{8y^3}$

Example 13 — Self Tutor

Write without brackets or negative indices:

a 2^{-2} **b** $5^0 - 5^{-1}$ **c** $\left(\frac{2}{5}\right)^{-2}$

a 2^{-2}

$= \dfrac{1}{2^2}$

$= \frac{1}{4}$

b $5^0 - 5^{-1}$

$= 1 - \frac{1}{5}$

$= \frac{4}{5}$

c $\left(\frac{2}{5}\right)^{-2}$

$= \left(\frac{5}{2}\right)^2$

$= \frac{25}{4}$

$= 6\frac{1}{4}$

Notice that $\left(\dfrac{a}{b}\right)^{-2} = \left(\dfrac{b}{a}\right)^2$

B EXAMPLES INDEX LAWS

Example 14 Self Tutor

Write without brackets or negative indices:

a $(5x)^{-1}$ **b** $5x^{-1}$ **c** $(3b^2)^{-2}$

a $(5x)^{-1}$

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

b $5x^{-1}$

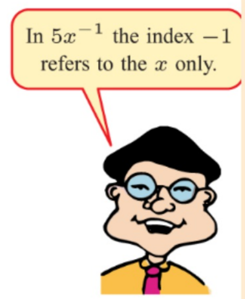
$= \frac{5}{x}$

c $(3b^2)^{-2}$

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

$= \frac{1}{3^2b^4}$

$= \frac{1}{9b^4}$



Practice (***2B, Page 28 - 32***) Rate your confidence of manipulating indices:

I'm building confidence: (**a - f**)
(1, 2, 3, 4, 9)

I'm somewhat confident: (**a - f**)
(1, 2, 4, 5, 7, 8, 9)

I'm very confident: (**a - f**)
(4, 5, 7, 8, 10, 11)

EXERCISE 2B

1 Simplify using the index law $a^m \times a^n = a^{m+n}$:

a $5^4 \times 5^2$ **b** $6^5 \times 6^6$ **c** $a \times a^5$ **d** $a^3 \times a^7$

e $b^{12} \times b^2$ **f** $a^2 \times a^n$ **g** $b^m \times b^9$ **h** $p^2 \times p \times p^4$

2 Simplify using the index law $\frac{a^m}{a^n} = a^{m-n}$:

a $\frac{3^9}{3^2}$ **b** $\frac{7^{13}}{7^9}$ **c** $5^7 \div 5^4$ **d** $\frac{a^8}{a^3}$

e $\frac{b^{18}}{b^{12}}$ **f** $\frac{p^n}{p^2}$ **g** $\frac{y^5}{y^b}$ **h** $b^{2n} \div b$

3 Simplify using the index law $(a^m)^n = a^{mn}$:

a $(2^9)^2$ **b** $(3^7)^3$ **c** $(5^4)^7$ **d** $(a^2)^6$

e $(q^3)^3$ **f** $(d^6)^n$ **g** $(x^y)^8$ **h** $(g^{2a})^5$

4 Simplify:

a 4^0 **b** $\left(\frac{2}{3}\right)^0$ **c** 12^0 **d** $2^0 + 2^2$

e a^0 **f** $(13^3)^0$ **g** $3y^0$ **h** $(3y)^0$

i $d^2 \times d^0$ **j** $\frac{c^7}{c^7}$ **k** $2 + 3^0$ **l** $8 - 9^0$

5 Simplify using one or more of the index laws:

a $\dfrac{b^4}{b}$ **b** $3c^2 \times 5c^3$ **c** $\dfrac{a^3b^2}{ab^2}$ **d** $\dfrac{18d^8}{3d^3}$

e $\dfrac{14p^3q^4}{2pq}$ **f** $12st^3 \times 3s^3$ **g** $\dfrac{y^{12}}{(y^2)^5}$ **h** $\dfrac{q^3 \times q^6}{(q^2)^3}$

i $\dfrac{6x^3y^2}{3x^3y}$ **j** $\dfrac{w^2z^4}{(wz^2)^2}$ **k** $\dfrac{a^4 \times a^2}{b(a^2)^3}$ **l** $\dfrac{16p^7q^6}{(2pq^2)^3}$

7 Remove the brackets of:

a $(pq)^3$ **b** $(ab)^5$ **c** $(xy)^4$ **d** $(pqr)^5$

e $(3a)^3$ **f** $(5b)^2$ **g** $(2n)^5$ **h** $(4ab)^3$

i $(9ab)^2$ **j** $\left(\dfrac{x}{y}\right)^4$ **k** $\left(\dfrac{a}{b}\right)^7$ **l** $\left(\dfrac{c}{2d}\right)^6$

m $\left(\dfrac{3x}{y^2}\right)^2$ **n** $\left(\dfrac{w^2}{2v}\right)^2$ **o** $\left(\dfrac{2r}{3s^2}\right)^3$ **p** $\left(\dfrac{3a^2}{ab}\right)^4$

8 Express in simplest form, without brackets:

a $(3a^2)^2$ **b** $\left(\dfrac{2}{p^2q}\right)^4$ **c** $(3cd^4)^3$ **d** $\left(\dfrac{a^4}{3n^7}\right)^2$

e $\left(\dfrac{2x^2}{y^6}\right)^3$ **f** $(2s^3t^4)^5$ **g** $\left(\dfrac{4g^5}{h^2}\right)^2$ **h** $\left(\dfrac{3x^2y^3}{4z}\right)^4$

9 Write without brackets or negative indices:

a 2^{-1} **b** 3^{-1} **c** 6^{-1} **d** 8^{-1}

e 3^2 **f** 3^{-2} **g** 2^3 **h** 2^{-3}

i 5^2 **j** 5^{-2} **k** 10^2 **l** 10^{-2}

10 Write without brackets or negative indices:

a $\dfrac{3^2}{3^4}$ b $\dfrac{2^{10}}{2^{15}}$ c $\left(4^{-1}\right)^2$ d $\left(7^2\right)^{-1}$

e $\left(\frac{1}{3}\right)^{-1}$ f $\left(\frac{2}{5}\right)^{-1}$ g $\left(\frac{4}{3}\right)^{-1}$ h $\left(\frac{1}{12}\right)^{-1}$

i $\left(3\frac{1}{2}\right)^{-1}$ j $3^0 - 3^{-1}$ k $7^{-1} + 7^0$ l $2^0 + 2^1 + 2^{-1}$

m $\left(\frac{3}{4}\right)^{-2}$ n $5 + 5^{-2}$ o $\left(\frac{5}{2}\right)^{-2}$ p $\left(2\frac{1}{3}\right)^{-2}$

11 Write without brackets or negative indices:

a $(2x)^{-1}$ b $2x^{-1}$ c $3b^{-1}$ d $(3b)^{-1}$

e $(2b)^{-2}$ f $\left(\dfrac{2}{b}\right)^{-2}$ g $\left(\dfrac{1}{n}\right)^{-2}$ h $(3n^{-2})^{-1}$

i $(ab)^{-1}$ j ab^{-1} k ab^{-2} l $(ab)^{-2}$

m $(2ab)^{-1}$ n $2(ab)^{-1}$ o $2ab^{-1}$ p $\dfrac{(ab)^2}{b^{-1}}$

Solutions to 2B

EXERCISE 2B

1	**a** 5^6	**b** 6^{11}	**c** a^6	**d** a^{10}
	e b^{14}	**f** a^{2+n}	**g** b^{m+9}	**h** p^7
2	**a** 3^7	**b** 7^4	**c** 5^3	**d** a^5
	e b^6	**f** p^{n-2}	**g** y^{5-b}	**h** b^{2n-1}
3	**a** 2^{18}	**b** 3^{21}	**c** 5^{28}	**d** a^{12}
	e q^9	**f** d^{6n}	**g** x^{8y}	**h** g^{10a}

4 **a** 1 **b** 1 **c** 1 **d** 5 **e** 1 provided $a \neq 0$
f 1 **g** 3 provided $y \neq 0$ **h** 1 provided $y \neq 0$
i d^2 provided $d \neq 0$ **j** 1 provided $c \neq 0$ **k** 3 **l** 7

5	**a** b^3	**b** $15c^5$	**c** a^2	**d** $6d^5$
	e $7p^2q^3$	**f** $36s^4t^3$	**g** y^2	**h** q^3
	i $2y$	**j** 1	**k** $\frac{1}{b}$	**l** $2p^4$

Solutions to 2B

6	a	2^4	b	3^3	c	5^3	d	2^6
	e	3^6	f	2^{a+2}	g	7^{t-1}	h	2^{4k}
	i	2^{5-x}	j	5^3	k	$7^{4(a-1)}$	l	3^2
	m	3^{y-2x}	n	2^{2y-3x}	o	11^{2x}	p	5^3
7	a	p^3q^3	b	a^5b^5	c	x^4y^4	d	$p^5q^5r^5$
	e	$27a^3$	f	$25b^2$	g	$32n^5$	h	$64a^3b^3$
	i	$81a^2b^2$	j	$\frac{x^4}{y^4}$	k	$\frac{a^7}{b^7}$	l	$\frac{c^6}{64d^6}$
	m	$\frac{9x^2}{y^4}$	n	$\frac{w^4}{4v^2}$	o	$\frac{8r^3}{27s^6}$	p	$\frac{81a^4}{b^4}$

Solutions to 2B

8	a	$9a^4$	b	$\frac{16}{p^8q^4}$	c	$27c^3d^{12}$	d	$\frac{a^8}{9n^{14}}$				
	e	$\frac{8x^6}{y^{18}}$	f	$32s^{15}t^{20}$	g	$\frac{16g^{10}}{h^4}$	h	$\frac{81x^8y^{12}}{256z^4}$				
9	a	$\frac{1}{2}$	b	$\frac{1}{3}$	c	$\frac{1}{6}$	d	$\frac{1}{8}$	e	9	f	$\frac{1}{9}$
	g	8	h	$\frac{1}{8}$	i	25	j	$\frac{1}{25}$	k	100	l	$\frac{1}{100}$
10	a	$\frac{1}{9}$	b	$\frac{1}{32}$	c	$\frac{1}{16}$	d	$\frac{1}{49}$	e	3	f	$2\frac{1}{2}$
	g	$\frac{3}{4}$	h	12	i	$\frac{2}{7}$	j	$\frac{2}{3}$	k	$1\frac{1}{7}$	l	$3\frac{1}{2}$
	m	$1\frac{7}{9}$	n	$5\frac{1}{25}$	o	$\frac{4}{25}$	p	$\frac{9}{49}$				
11	a	$\frac{1}{2x}$	b	$\frac{2}{x}$	c	$\frac{3}{b}$	d	$\frac{1}{3b}$	e	$\frac{1}{4b^2}$	f	$\frac{b^2}{4}$
	g	n^2	h	$\frac{n^2}{3}$	i	$\frac{1}{ab}$	j	$\frac{a}{b}$	k	$\frac{a}{b^2}$	l	$\frac{1}{a^2b^2}$
	m	$\frac{1}{2ab}$	n	$\frac{2}{ab}$	o	$\frac{2a}{b}$	p	a^2b^3				