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Name	Common Notation	Math Notation	Exponent	Prefix
Quintillion	1 000 000 000 000 000 000	10^{18}	18	Exa (E)
Quadrillion	1 000 000 000 000 000	10^{15}	15	Peta (P)
Trillion	1 000 000 000 000	10^{12}	12	Tera (T)
Billion	1 000 000 000	10^{9}	9	Giga (G)
Million	1 000 000	10^{6}	6	Mega (M)
Thousand	1 000	10^{3}	3	kilo (k)
Hundred	100	10^{2}	2	hecto (h)
Ten	10	10^{1}	1	Deca (da)
One	1	10^{0}	0	
One Tenth	0.1	10^{-1}	-1	deci (d)
One Hundredth	0.01	10^{-2}	-2	centi (c)
One Thousandth	0.001	10^{-3}	-3	milli (m)
One Millionth	0.000 001	10^{-6}	-6	micro (μ)
One Billionth	0.000 000 001	10^{-9}	-9	nano (n)
One Trillionth	0.000 000 000 001	10^{-12}	-12	pico (p)
One Quadrillionth	0.000 000 000 000 001	10^{-15}	-15	femto (f)
One Quintillionth	0.000 000 000 000 000 001	10^{-18}	-18	atto (a)

How much of this info do you know? What are the patterns with the values? Did you know all the Latin shown here? What are 'Negative Powers' all about?

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1	$186 \div 10^{4} =$			
2	$186 \div 10^{3} =$			
3	$186 \div 10^{2} =$			
4	$186 \div 10^{1} =$	$186 \div 10$	$\frac{186}{10}$	18.6
5	$186 \div 10^{0} =$			
6	$186 \div 10^{-1} =$	$186 \div 0.1$	$\frac{186}{1} \div \frac{1}{10} =$ $\frac{186}{1} \times \frac{10}{1} =$	1,860
7	$186 \div 10^{-2} =$			

Can you complete the table above with the missing values?

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Analyzing Positive Powers of 10

1. What is the connection between the exponent on the 10 and the number of 0's after the 1?

   _____

   _____

2. What is the connection between the exponent on the 10 and the number of times we moved the decimal point?

   _____

   _____

3. What direction did we move the decimal point?

   _____

   _____

10^{-6}

1000000

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Evaluate each expression.

1. $123 \times 1{,}000$ 123,000

2. $123 \div 1{,}000$ 0.123

3. 0.003×100 0.3

4. $0.003 \div 100$ 0.00003

5. 10^4 10,000

6. 10^{-4} 0.0001

7. 23^0 1

The answers are all there, but can you follow what happened in each case to get the answer?

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Write each number in scientific notation.

1) $6{,}201{,}000{,}000$ 6.201×10^{9}

2) 0.00432 4.32×10^{-3}

Write each in standard notation.

3) 8.11×10^{7} $81{,}100{,}000$

4) 3.805×10^{-4} 0.0003805

Brave enough to make your own examples??

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- Simplify the following. Then find the value

Example: $2^2 \cdot 2^3 = 2^5 = 32$

1. $3^9 \cdot 3^{-7}$
2. $(100^{23})^0$
3. $\frac{12^{-3}}{12^{-5}}$
4. $\frac{6^{10}.5^{-3}}{5^{-3}.6^8}$

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

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

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

4) $(ab)^n = a^n b^n$

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

6) $\frac{1}{a} = a^{-1}$

7) $\frac{1}{a^n} = a^{-n}$

8) $a^0 = 1$

9) $\sqrt{a} = a^{\frac{1}{2}}$

10) $\sqrt[n]{a} = a^{\frac{1}{n}}$

11) $\sqrt{ab} = \sqrt{a}\sqrt{b}$

12) $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

13) $(\sqrt[n]{a})^m = \sqrt[n]{a^m} = a^{\frac{m}{n}}$

How many of the indices rules do you know and can use? Try changing the letters to numbers and working some sums out

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Dividing by Powers of Ten (B)

Dividing by all positive powers of ten

$3{,}500 \div 10^2 =$	$490{,}000 \div 10^2 =$
$500{,}000 \div 10^3 =$	$38{,}000 \div 10^1 =$
$5{,}200 \div 10^2 =$	$9{,}900{,}000 \div 10^3 =$
$2{,}000 \div 10^1 =$	$8{,}000 \div 10^1 =$
$180 \div 10^0 =$	$96{,}000 \div 10^3 =$
$71{,}000 \div 10^3 =$	$900 \div 10^1 =$

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Laws of Indices

Literacy

Explain and illustrate the types of numbers you know that use indices.

RoK (Retention of Knowledge)

Express in Index Form

1) $5 \times 5 \times 5 \times 5$ 2) $8 \times 9 \times 9 \times 9$ 3) $\frac{1}{2\times2\times2}$

4) $\sqrt{8}$ 5) $\frac{3\times3\times3\times3}{3\times3}$ 6) $\frac{5\times5\times5\times7}{5\times5\times5\times5\times7\times7}$

Skill 1

Simplify

1) $y^5 \times y^2$
2) $p^5 \div p^2$
3) $w^{-4} \times w^7$
4) $q^{-3} \div q^8$
5) $t^{-3} \div t^{-8}$
6) $2h^2 \times 3h^4$
7) $9r^5 \div 3r^2$
8) $4p \times 5p^3$
9) $(x^5)^4$
10) $(2x^3)^2$
11) $(3x)^2 \times (2x)^2$
12) $(2x)^3 \div 8x^0$

Skill 2

Evaluate

1) $5^2 \times 5^3$
2) 4^{-2}
3) 500^0
4) $9^2 \times 3^{-2}$
5) $3^6 \div 3^4$
6) $2^{-2} \times 2^6$
7) $(2^3)^2$
8) $(3.79)^0$
9) 5^{-3}
10) $3^3 \div 3^{-1}$
11) $(3 \times 2^2)^2$
12) $\left(3^{\frac{1}{2}}\right)^2$

Skill 3

Simplify

1) $(t^{-2})^{-4}$
2) $p^{\frac{1}{2}} \times p^{\frac{1}{2}}$
3) $\left(r^{\frac{1}{2}}\right)^4$
4) $(y^5)^{\frac{1}{2}}$
5) $\left(q^{\frac{1}{5}}\right)^5 \times \left(q^{\frac{2}{3}}\right)^3$

Skill 4

Evaluate

1) $9^{\frac{1}{2}}$
2) $125^{\frac{1}{3}}$
3) $27^{\frac{2}{3}}$
4) $100^{-\frac{3}{2}}$
5) $64^{\frac{1}{3}} \times 81^{\frac{1}{2}}$
6) $\left(100^{\frac{1}{2}}\right)^{-4}$

Stretch 1

Solve these equations for x.

1) $5^x = 125$ 2) $2^{-x} = \frac{1}{8}$ 3) $23^x = 1$

4) $3^{2x} = 9$ 5) $10^x = 0.0001$ 6) $5^x + 2^x = 133$

Stretch 2

Consider the function $f(x) = \left(1 - \frac{1}{x}\right)^x$

So $f(1) = \left(1 + \frac{1}{1}\right)^1 = 2$

$f(2) = \left(1 + \frac{1}{2}\right)^2 = 2.25$

a) Find the value of $f(3), f(4)$ *and* $f(5)$

b) Find the value of $f(10), f(100)$ *and* $f(1000)$

c) When $\lim_{n\to\infty} \left(1 + \frac{1}{n}\right)^n$

What is the limit of the function, $f(x)$, when x tends to infinity.

Laws of indices Memory

1) $a^n \times a^m = a^{n+m}$

Example: $3^2 \times 3^5 = 3^{3+5} = 3^8$

2) $a^n \div a^m = a^{n-m}$

Example: $7^9 \div 7^4 = 7^{9-4} = 7^5$

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

Example: $(5^3)^2 = 5^{3\times2} = 5^6$

4) $a^{-n} = \frac{1}{a^n}$

Example: $3^4 \div 3^6 = \frac{\cancel{3}\times\cancel{3}\times\cancel{3}\times\cancel{3}}{\cancel{3}\times\cancel{3}\times\cancel{3}\times\cancel{3}\times3\times3} = \frac{1}{3^2} = 3^{-2}$

5) $a^{\frac{1}{n}} = \sqrt[n]{a}$ (means the nth root of a)

Example: $5^{\frac{1}{2}} = \sqrt[2]{5}$ or $5^{\frac{1}{3}} = \sqrt[3]{5}$

6) $a^{\frac{n}{m}} = \sqrt[m]{a^n}$

Example: $7^{\frac{3}{2}} = \sqrt[2]{7^3}$

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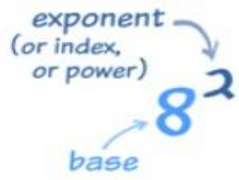
Literacy



Research

What is the value of 0^2?

What is the value of 0^{-2}?

What is the value of 0^0?

Memory

Learn these rules:

$x^a \times x^b = x^{a+b}$

$x^a \div x^b = x^{a-b}$

$(x^a)^b = x^{ab}$

$x^0 = 1$

Skills

Use index laws to simplify:

a) $p^2 \times p^5$
b) $p^{12} \div p^4$
c) $(p^3)^7$
d) $p^0 \times q^3$
e) $3p^4 \times 5p^2$
f) $6pq^3 \times 2p^9q^2$
g) $\frac{p^7}{p^2}$
h) $\frac{8p^{11}}{2p^9}$
i) $(2p^4)^3$
j) $\frac{8q^2 \times 3q^7}{6q^8}$

Stretch

Find the value of:

a) $2^{20} \div 4^{10}$
b) $(2^6)^2 \div 4^5$
c) $3^7 \div 9^3$
d) $27^5 \div 3^{12}$

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Change these decimals into standard form.

94000 = ☐ × 10☐ [1]

8400000 = ☐ × 10☐ [1]

0.068 = ☐ × 10☐ [1]

0.00098 = ☐ × 10☐ [1]

Change these standard form numbers into ordinary decimals.

2.1×10^{7} = ☐ [1]

3.54×10^{3} = ☐ [1]

7.5×10^{-3} = ☐ [1]

1.88×10^{-3} = ☐ [1]

Simplify these expressions.

$3^2 \times 3^6$ = ☐ [1]

$5^5 \times 5^7$ = ☐ [1]

$6^3 \times 6^9$ = ☐ [1]

$6^7 \div 6^3$ = ☐ [1]

$5^{13} \div 5^8$ = ☐ [1]

$9^{14} \div 9^7$ = ☐ [1]

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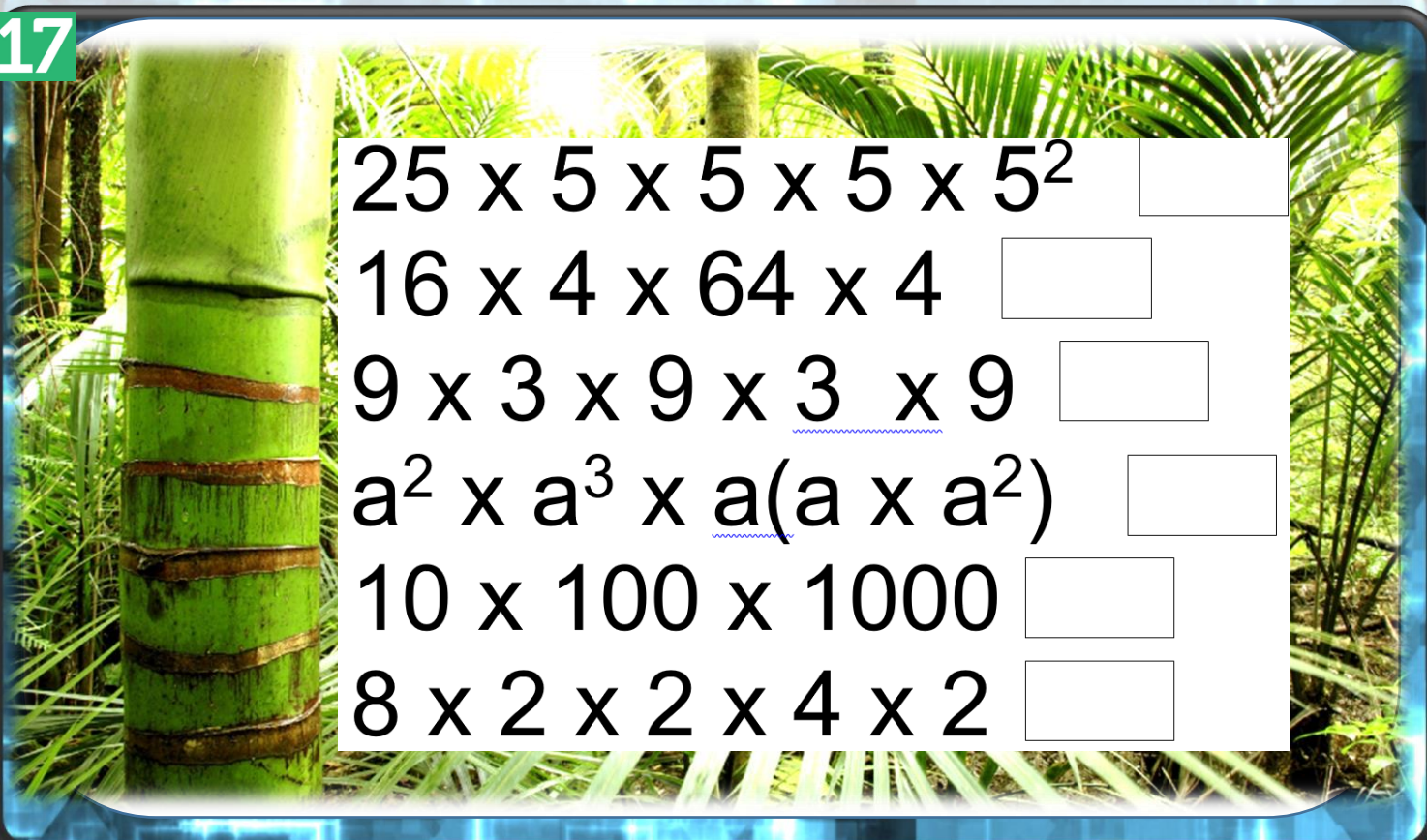

$25 \times 5 \times 5 \times 5 \times 5^2$ ☐

$16 \times 4 \times 64 \times 4$ ☐

$9 \times 3 \times 9 \times 3 \times 9$ ☐

$a^2 \times a^3 \times a(a \times a^2)$ ☐

$10 \times 100 \times 1000$ ☐

$8 \times 2 \times 2 \times 4 \times 2$ ☐

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Indices Practice Sheet: standard level

A

1. $8^2 \div 8^3$
2. $u^4 \times u^5$
3. $2^1 \times 2^4$
4. $s^1 \div s^2$
5. $10^{-6} \times 10^{-4}$
6. $d^{-5} \times d^{-6}$
7. $11^{-6} \times 11^{-3}$
8. $\frac{t^0 \times t^7}{t^{-6}}$
9. $\frac{n^6 \times n^7}{n^5}$
10. $\frac{m^{-1} \times m^9}{m^{-12}}$

B

1. $(p^2)^1$
2. $(m^2)^6$
3. $s^2 \div s^7$
4. $(s^0)^7$
5. $k^0 \times k^4$
6. $m^{-9} \times m^4$
7. $22^{-11} \times 22^{-8}$
8. $\frac{21^{-10} \times 21^{-9}}{21^5}$
9. $\frac{a^{10} \times a^2}{a^{-2}}$
10. $\frac{z^6 \times z^{-13}}{z^{-1}}$

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Question 1

(a) 4.256×10^6

(b) 6.65×10^3

Question 2

(a)

(i) $1.4 \times 10^{-6} cm$

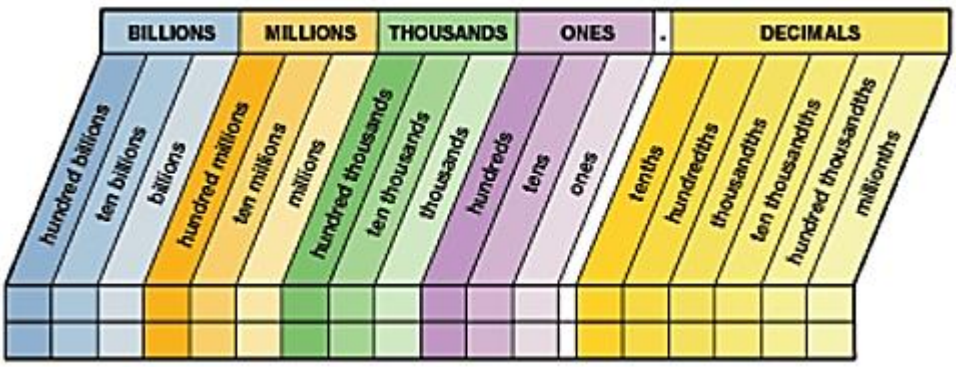
(ii) $8.8 \times 10^{-6} cm$

(iii) $6.16 \times 10^{-12} cm^2$

(b)

(i) $4 \times 10^{-3} m$

(ii) $4 \times 10^{-5} m$



Can you write each of the values in the questions onto a place value table?