

WALT - apply negative Indices

Success Criteria I know negative power means it changes to the denominator for a decimal value

Recap on indices rules

List of Indices Laws

- $x^0 = 1$
- $x^{-n} = \frac{1}{x^n}$
- $x^n \cdot x^m = x^{n+m}$
- $x^n \div x^m = x^{n-m}$
- $(x^n)^m = x^{n \cdot m}$
- $x^{\frac{n}{m}} = \sqrt[m]{x^n}$

EXTRA Practice

<https://drive.google.com/file/d/16oth8EX9OPbEw087jNc-S53cMrtaHBRx/view?usp=sharing>

Use the link to practice more indices

View

[Negative Indices explained](#) - Fractional for extra information

[The correct negative indices](#) We saw

Play Kahoot on the previous learning



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EXAMPLE 1

Complete the table to find the meaning of 3^{-1} , 3^{-2} , 3^{-3} .

3^3	3^2	3^1	3^0	3^{-1}	3^{-2}	3^{-3}
27	9	3				

Check your answers

Solve							Think/Apply
3^3	3^2	3^1	3^0	3^{-1}	3^{-2}	3^{-3}	Each number in the second row can be found by multiplying the number before it by $\frac{1}{3}$. Multiplying a number by $\frac{1}{3}$ is the same as dividing it by 3. !
27	9	3	1	$\frac{1}{3}$	$\frac{1}{9} = \frac{1}{3^2}$	$\frac{1}{27} = \frac{1}{3^3}$	

- 1 Multiply the numbers in the second row by $\frac{1}{2}$ to complete the table. Hence find the meaning of 2^{-1} , 2^{-2} , 2^{-3} .

2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}
8	$8 \times \frac{1}{2} = \underline{\quad}$	$\underline{\quad} \times \frac{1}{2} = \underline{\quad}$				

Hence $2^{-1} = \frac{1}{\square} = \frac{1}{2^{\square}}$ $2^{-2} = \frac{1}{\square} = \frac{1}{2^{\square}}$ $2^{-3} = \frac{1}{\square} = \frac{1}{2^{\square}}$

- 2 Multiply the numbers in the second row by $\frac{1}{10}$ to complete the table and find the meaning of 10^{-1} , 10^{-2} , 10^{-3} .

10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}
1000						

Hence $10^{-1} = \frac{1}{\square} = \frac{1}{10^{\square}}$ $10^{-2} = \frac{1}{\square} = \frac{1}{10^{\square}}$ $10^{-3} = \frac{1}{\square} = \frac{1}{10^{\square}}$

Check Your Answers

1	2^3	2^2	2^1	2^0
	8	$8 \times \frac{1}{2} = 4$	$4 \times \frac{1}{2} = 2$	$2 \times \frac{1}{2} = 1$

2^{-1}	2^{-2}	2^{-3}
$1 \times \frac{1}{2} = \frac{1}{2}$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$

Hence $2^{-1} = \frac{1}{2} = \frac{1}{2^1}$

$$2^{-2} = \frac{1}{4} = \frac{1}{2^2}$$

$$2^{-3} = \frac{1}{8} = \frac{1}{2^3}$$

2	10^3	10^2	10^1	10^0
	1000	$1000 \times \frac{1}{10} = 100$	$100 \times \frac{1}{10} = 10$	$10 \times \frac{1}{10} = 1$

10^{-1}	10^{-2}	10^{-3}
$1 \times \frac{1}{10} = \frac{1}{10}$	$\frac{1}{10} \times \frac{1}{10} = \frac{1}{100}$	$\frac{1}{100} \times \frac{1}{10} = \frac{1}{1000}$

Hence $10^{-1} = \frac{1}{10} = \frac{1}{10^1}$

$$10^{-2} = \frac{1}{100} = \frac{1}{10^2}$$

$$10^{-3} = \frac{1}{1000} = \frac{1}{10^3}$$

EXAMPLE 2

- a** Use the index laws to simplify $3^4 \div 3^6$.
b Write in expanded form and show that $3^4 \div 3^6 = \frac{1}{3^2}$.
c Hence show that $3^{-2} = \frac{1}{3^2}$.

	Solve/Think	Apply
a	$3^4 \div 3^6 = 3^{4-6} = 3^{-2}$	Simplify using the index laws and by writing in expanded form and cancelling. In general: $3^{-n} = \frac{1}{3^n}$
b	$3^4 \div 3^6 = \frac{\cancel{3} \times \cancel{3} \times \cancel{3} \times \cancel{3}}{\cancel{3} \times \cancel{3} \times \cancel{3} \times \cancel{3} \times 3 \times 3} = \frac{1}{3^2}$	
c	From parts a and b , $3^{-2} = \frac{1}{3^2}$.	

- 3 a** Use the index laws to simplify $5^3 \div 5^7$.
- b** By writing in expanded form, show that $5^3 \div 5^7 = \frac{1}{5^4}$.
- c** Hence show that $5^{-4} = \frac{1}{5^4}$.
- 4** Write the following with positive indices.
- | | | | | |
|--------------------|-------------------|--------------------|--------------------|--------------------|
| a 3^{-1} | b 4^{-3} | c 2^{-5} | d 8^{-2} | e 5^{-4} |
| f 12^{-1} | g 9^{-2} | h 6^{-1} | i 7^{-3} | j 3^{-6} |
| k 2^{-8} | l 5^{-1} | m 10^{-5} | n 5^{-10} | o 4^{-15} |

Check your answers

3 a $5^3 \div 5^7 = 5^{3-7} = 5^{-4}$

b $5^3 \div 5^7 = \frac{5 \times 5 \times 5}{5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5} = \frac{1}{5^4}$

c From parts **a** and **b**, $5^{-4} = \frac{1}{5^4}$

4 a $\frac{1}{3}$ **b** $\frac{1}{4^3}$ **c** $\frac{1}{2^5}$ **d** $\frac{1}{8^2}$ **e** $\frac{1}{5^4}$

f $\frac{1}{12}$ **g** $\frac{1}{9^2}$ **h** $\frac{1}{6}$ **i** $\frac{1}{7^3}$ **j** $\frac{1}{3^6}$

k $\frac{1}{2^8}$ **l** $\frac{1}{5}$ **m** $\frac{1}{10^5}$ **n** $\frac{1}{5^{10}}$ **o** $\frac{1}{4^{15}}$



EXAMPLE 3

Write the following as simplified fractions or mixed numerals.

a 5^{-2}

b 3^{-5}

	Solve	Think	Apply
a	$5^{-2} = \frac{1}{25}$	$5^{-2} = \frac{1}{5^2}$ $= \frac{1}{25}$	Write with a positive index then evaluate using a calculator if necessary.
b	$3^{-5} = \frac{1}{243}$	$3^{-5} = \frac{1}{3^5}$ $= \frac{1}{243}$	

5 Write the following as simplified fractions or mixed numerals.

a 3^{-2}

b 2^{-5}

c 4^{-3}

d 5^{-4}

e 2^{-10}

f 6^{-3}

g 9^{-2}

h 3^{-4}

i 5^{-5}

j 2^{-9}

k 7^{-3}

l 4^{-4}

m 3^{-5}

n $\left(\frac{2}{5}\right)^{-1}$

o $\left(1\frac{3}{4}\right)^{-1}$

EXAMPLE 4

Write the following with negative indices.

a $\frac{1}{3}$

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

c $\frac{1}{3^5}$

	Solve/Think	Apply
a	$\frac{1}{3} = \frac{1}{3^1} = 3^{-1}$	$3^{-n} = \frac{1}{3^n}$ is equivalent to $\frac{1}{3^n} = 3^{-n}$.
b	$\frac{1}{3^2} = 3^{-2}$	
c	$\frac{1}{3^5} = 3^{-5}$	

6 Write the following with negative indices.

a $\frac{1}{2}$

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

c $\frac{1}{2^8}$

d $\frac{1}{2^5}$

e $\frac{1}{2^3}$

f $\frac{1}{5}$

g $\frac{1}{7^2}$

h $\frac{1}{4^3}$

i $\frac{1}{3^4}$

j $\frac{1}{5^6}$

k $\frac{1}{3^{10}}$

l $\frac{1}{6}$

m $\frac{1}{7^3}$

n $\frac{1}{4^9}$

o $\frac{1}{10}$

Check your answers

5 a	$\frac{1}{9}$	b	$\frac{1}{32}$	c	$\frac{1}{64}$	d	$\frac{1}{625}$	e	$\frac{1}{1024}$
f	$\frac{1}{216}$	g	$\frac{1}{81}$	h	$\frac{1}{81}$	i	$\frac{1}{3125}$	j	$\frac{1}{512}$
k	$\frac{1}{343}$	l	$\frac{1}{256}$	m	$\frac{1}{729}$	n	$2\frac{1}{2}$	o	$\frac{4}{7}$
6 a	2^{-1}	b	2^{-2}	c	2^{-8}	d	2^{-5}	e	2^{-3}
f	5^{-1}	g	7^{-2}	h	4^{-3}	i	3^{-4}	j	5^{-6}
k	3^{-10}	l	6^{-1}	m	7^{-5}	n	4^{-9}	o	10^{-1}

EXAMPLE 5

Write $\frac{1}{5^{-3}}$ with a positive index.

Solve/Think	Apply
$\frac{1}{5^{-3}} = \frac{1}{\frac{1}{5^3}}$ $= 1 \times \frac{5^3}{1}$ $= 5^3$ <p>Or $\frac{1}{5^{-3}} = \frac{5^0}{5^{-3}}$</p> $= 5^{0 - (-3)}$ $= 5^3$	<p>Write 5^{-3} with a positive index and divide the fractions. Or write 1 as 5^0 and divide using the index laws.</p> <p>To divide by a fraction, invert the fraction (turn it upside down) and multiply. !</p>

7 Write the following with positive indices.

a $\frac{1}{3^{-4}}$

b $\frac{1}{2^{-7}}$

c $\frac{1}{7^{-2}}$

d $\frac{1}{6^{-1}}$

e $\frac{1}{4^{-5}}$

EXAMPLE 6

Evaluate $(\frac{3}{7})^{-1}$.

Solve/Think	Apply
$(\frac{3}{7})^{-1} = \frac{1}{\frac{3}{7}}$ $= 1 \times \frac{7}{3}$ $= \frac{7}{3} \text{ or } 2\frac{1}{3}$	<p>Write $(\frac{3}{7})^{-1}$ with a positive index and divide the fractions.</p>

8 Evaluate the following.

a $(\frac{2}{3})^{-1}$

b $(\frac{3}{4})^{-1}$

c $(\frac{7}{8})^{-1}$

d $(\frac{1}{5})^{-1}$

e $(\frac{1}{10})^{-1}$

f $(\frac{1}{2})^{-1}$

g $(2\frac{3}{4})^{-1}$

9 Using the results of questions 7 and 8, simplify $(\frac{a}{b})^{-1}$.

Check your answers

7 a 3^4	b 2^7	c 7^2	d $6^1 = 6$	e 4^5
8 a $1\frac{1}{2}$	b $1\frac{1}{3}$	c $1\frac{1}{7}$	d 5	
e 10	f $\frac{2}{3}$	g $\frac{4}{11}$		
9 $\frac{b}{a}$				

Next session We will work with variables for negative indices

Day two Week two

WALT solve linear equations

Success criteria I can add and subtract numbers to both sides until variable/unknown/pronumeral is one side and the number is on the other side

EXAMPLE 1

Solve these linear equations.

a $7x - 9 = -5$

b $17 = 8 - 4x$

	Solve	Think	Apply
a	$7x - 9 = -5$ $7x - 9 + 9 = -5 + 9$ $7x = 4$ $\frac{7x}{7} = \frac{4}{7}$ $x = \frac{4}{7}$	<p>Add 9 to both sides.</p> <p>Divide both sides by 7.</p>	<p>Add or subtract numbers to both sides until the pronumeral is on one side and a number is on the other side.</p> <p>Multiply or divide to solve.</p>
b	$17 = 8 - 4x$ $17 - 8 = 8 - 4x - 8$ $9 = -4x$ $\frac{9}{-4} = \frac{-4x}{-4}$ $\frac{-9}{4} = x$ $x = -\frac{9}{4}$ $= -2\frac{1}{4}$	<p>Subtract 8 from both sides.</p> <p>Divide both sides by -4.</p> <p>Write the solution with x on the left-hand side.</p>	

Exercise 12A

1 Solve for x in the following equations.

a $x + 3 = 10$

b $3x = -9$

c $3x + 6 = 0$

d $3x - 4 = -6$

e $5x + 8 = 2$

f $4x - 9 = 1$

g $8x - 6 = 10$

h $3x + 6 = 7$

i $6 + 7x = -2$

j $5 = 3x + 7$

k $6x - 7 = -1$

l $-1 = 2x + 6$

m $6 - x = -5$

n $-4x = 15$

o $3 - 2x = 7$

p $5 - 4x = -7$

q $3 - 7x = -2$

r $17 - 2x = -1$

s $11 = 3 - 2x$

t $15 - 2x = -1$

u $8 = 3 - 2x$

v $6 = -1 - 7x$

w $-15 = 3 - 6x$

x $11 = -4 - 3x$



EXAMPLE 2

Solve for m in the equation $\frac{m}{3} - 5 = -2$.

Solve	Think	Apply
$\frac{m}{3} - 5 = -2$ $\frac{m}{3} - 5 + 5 = -2 + 5$ $\frac{m}{3} = 3$ $\frac{m}{3} \times 3 = 3 \times 3$ $m = 9$	<p>Add 5 to both sides.</p> <p>Multiply both sides by 3.</p>	<p>Add or subtract numbers first, then multiply to solve.</p>

2 Solve these equations for x .

a $\frac{x}{2} + 3 = 8$

b $\frac{x}{3} - 1 = 4$

c $\frac{x}{5} + 2 = -3$

d $\frac{x}{6} + 3 = -4$

e $\frac{x}{7} - 2 = 4$

f $\frac{x}{10} - 6 = -1$

3 Check the given solution by substitution and say whether or not it is correct.

a $2x + 8 = 15$ ($x = 7$)

b $7 + 5x = 9$ ($x = 2$)

c $-15 = 6 - 7x$ ($x = 3$)

d $\frac{x}{5} - 3 = 6$ ($x = \frac{9}{5}$)

Check your

EXAMPLE 3

If $y = 5x - 3$ find x when $y = -18$.

Solve	Think	Apply
$y = 5x - 3$ $-18 = 5x - 3$ $-18 + 3 = 5x - 3 + 3$ $-15 = 5x$ $\frac{-15}{5} = \frac{5x}{5}$ $-3 = x$ $x = -3$	<p>Substitute $y = -18$.</p> <p>Add 3 to both sides.</p> <p>Divide both sides by 5.</p>	<p>Often when substituting and solving an equation, the pronumeral is on the right-hand side. Solve as normal and then write the pronumeral on the left-hand side.</p>

4 a Given that $y = 3x - 5$, find x when $y = 5$.

b Given that $y = 4x + 2$, find x when $y = 11$.

c Given that $y = 7 - 5x$, find x when $y = 0$.

d Given that $y = 4 - 3x$, find x when $y = -3$.

e Given that $y = 5 - 7x$, find x when $y = -5$.

f Given that $y = 3x - 5$, find x when $y = 8$.

answers

Exercise 12A

- 1 a $x = 7$ b $x = -3$ c $x = -2$
 d $x = -\frac{2}{3}$ e $x = -\frac{6}{5}$ f $x = \frac{5}{2}$
 g $x = 2$ h $x = \frac{1}{3}$ i $x = -\frac{8}{7}$
 j $x = -\frac{2}{3}$ k $x = 1$ l $x = -\frac{7}{2}$
 m $x = 11$ n $x = -\frac{15}{4}$ o $x = -2$
 p $x = 3$ q $x = \frac{5}{7}$ r $x = 9$
 s $x = -4$ t $x = 8$ u $x = -\frac{5}{2}$
 v $x = -1$ w $x = 3$ x $x = -5$
- 2 a $x = 10$ b $x = 15$ c $x = -25$
 d $x = -42$ e $x = 42$ f $x = 50$
- 3 a No b No c Yes d No
- 4 a $x = \frac{10}{3}$ b $x = \frac{9}{4}$ c $x = \frac{7}{5}$
 d $x = \frac{7}{3}$ e $x = \frac{10}{7}$ f $x = \frac{13}{3}$