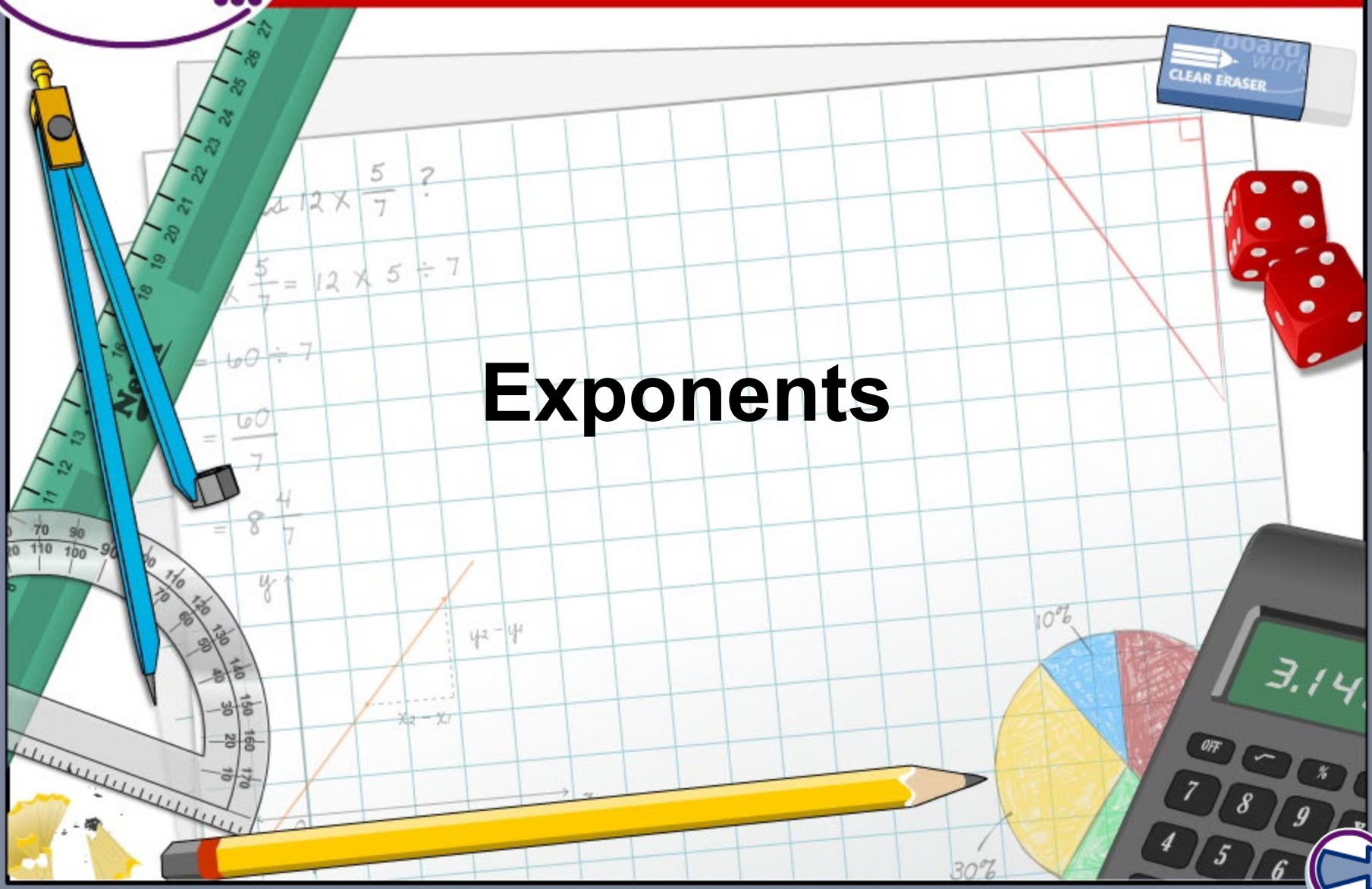


Exponents

Information

Common core icons

This icon indicates a slide where the Standards for Mathematical Practice are being developed. Details of these are given in the Notes field.

Slides containing examples of mathematical modeling are marked with this stamp.

This icon indicates an opportunity for discussion or group work.

The **Standards for Mathematical Practice** outlined in the Common Core State Standards for Mathematics describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

These are:

1) Make sense of problems and persevere in solving them.

2) Reason abstractly and quantitatively.

3) Construct viable arguments and critique the reasoning of others.

4) Model with mathematics.

5) Use appropriate tools strategically.

6) Attend to precision.

7) Look for and make use of structure.

8) Look for and express regularity in repeated reasoning.

This icon indicates that the slide contains activities created in Flash. These activities are not editable.

This icon indicates teacher's notes in the Notes field.

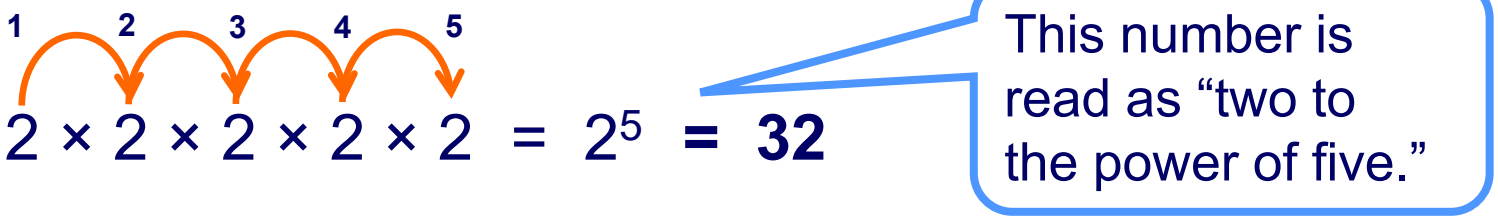
Introducing exponents

What is an exponent?

What are exponents used for?

We use **exponents** to show repeated multiplication by the same number.

For example, we can write **2 × 2 × 2 × 2 × 2** as:



The exponent is equal to the number of times the base is multiplied by itself.

Introducing exponents

What happens if the base is negative?

$(-3)^1 = (-3) = -3$

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

$(-3)^3 = (-3) \times (-3) \times (-3) = -27$

$(-3)^4 = (-3) \times (-3) \times (-3) \times (-3) = 81$

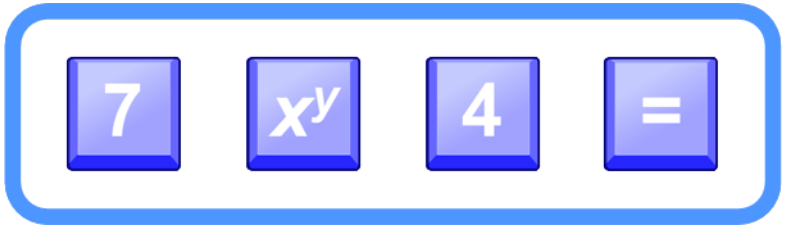
$(-3)^5 = (-3) \times (-3) \times (-3) \times (-3) \times (-3) = -243$

Only **odd exponents** produce negative values when they are evaluated.

Using a calculator

How do you evaluate exponents using a calculator?

We use the x^y key. To calculate the value of 7^4 we key in:



The calculator shows this as 2401.

$$7^4 = 7 \times 7 \times 7 \times 7 = 2401$$

If your calculator does not have the x^y key, you can press the ^ key instead.

Evaluating exponents

Evaluate the following:

$6^2 = 6 \times 6 = 36$

$3^4 = 3 \times 3 \times 3 \times 3 = 81$

$(-5)^3 = -5 \times -5 \times -5 = -125$

$2^7 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 128$

$(-4)^4 = -4 \times -4 \times -4 \times -4 = 64$

$(-1)^5 = -1 \times -1 \times -1 \times -1 \times -1 = -1$

When we raise a **negative** number to an **odd** power, the answer is **negative**.

When we raise a negative number to an **even** power, the answer is **positive**.

Will the last answer be positive or negative?

Evaluating activity

Complete these calculations involving exponent notation

$\square = 6 \times 6 = \square$

$\square = 2 \times 2 \times 2 \times 2 \times 2 = \square$

$\square = 3 \times 3 \times 3 \times 3 = \square$

$\square = -1 \times -1 = \square$

$\square = -5 \times -5 \times -5 = \square$

$\square = 4 \times 4 \times 4 \times 4 \times 4 = \square$

81

S C ?

Real life example

Morgan studies fruit flies.
Fruit flies reproduce very quickly.

The fruit fly population that Morgan studies doubles every 18 days.

This means that if Morgan starts with 10 fruit flies, 18 days later there will be 20 fruit flies.

Press **start** to see the questions.

start

Rules for multiplication

What do you think happens when we multiply two numbers written using exponents and the same base?

$7^3 \times 7^5 = (7 \times 7 \times 7) \times (7 \times 7 \times 7 \times 7 \times 7)$

$= 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7$

$= 7^8$

$3 + 5 = 8$

$3^6 = 3 \times 3 \times 3 \times 3 \times 3 \times 3$

$= (3 \times 3 \times 3 \times 3) \times (3 \times 3)$

$= 3^4 \times 3^2$

$6 = 4 + 2$

When we **multiply** two numbers with the **same base**, the exponents are **added**.

Rules for division

Can you predict the rule for dividing two numbers written using exponents and the same base?

For example:

$$4^5 \div 4^2 = \frac{\cancel{4} \times \cancel{4} \times 4 \times 4 \times 4}{\cancel{4} \times \cancel{4}} = 4 \times 4 \times 4 = 4^3 = 4^{(5-2)}$$

$$5^6 \div 5^4 = \frac{\cancel{5} \times \cancel{5} \times \cancel{5} \times \cancel{5} \times 5 \times 5}{\cancel{5} \times \cancel{5} \times \cancel{5} \times \cancel{5}} = 5 \times 5 = 5^2 = 5^{(6-4)}$$

When we **divide** two numbers with the **same base**, the exponents are **subtracted**.

Writing rules

When we **multiply** two numbers with the **same base**, the exponents are **added**.

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

a, m and n can take **any** value.

When we **divide** two numbers with the **same base**, the exponents are **subtracted**.

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

These rules can be written **algebraically**.

Negative exponents

We can use the rule for dividing exponents to find a new rule.
Can you simplify $3^2 \div 3^4$ to come up with a new rule?

Press the buttons for help:

cancel

substitute

equate

new rule

Exponents of 0

We can use the rule for dividing exponents to find a new rule.
Can you simplify $6^4 \div 6^4$ to come up with a new rule?

Press the buttons for help:

cancel

substitute

equate

new rule

More exponents

What if we raise an exponent and its base to another power?

$(5^2)^3$

$(5^2)^3 = (5 \times 5) \times (5 \times 5) \times (5 \times 5)$

$= 5 \times 5 \times 5 \times 5 \times 5 \times 5$

$= 5^6$

$2 \times 3 = 6$

When we **raise** a number that already has an exponent to another power, the exponents are **multiplied**.

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

Special cases

Use your calculator to evaluate the following:

10^1 3.452^1 $723{,}538{,}592^1$

$$a^1 = a$$

Any number raised to the power of 1 is equal to that number.

Now use your calculator to evaluate these:

$6^{-1} = \frac{1}{6}$ $7^{-1} = \frac{1}{7}$ $5^{-1} = \frac{1}{5}$

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

Any number with an exponent of -1 is 1 divided by that number.

Rules to remember

Here is a summary of these rules, written algebraically.

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

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

$$a^1 = a \qquad a^0 = 1$$

$$a^{-1} = \frac{1}{a} \qquad a^{-n} = \frac{1}{a^n}$$

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

Matching rules

Match the start of the index laws with the correct ending

$a^m \times a^n =$	$a^{(m+n)}$
$a^m \div a^n =$	$\frac{1}{a^n}$
$a^{-n} =$	1
$a^1 =$	$a^{(m-n)}$
$a^0 \ (a \neq 0) =$	a

Simplifying exponents

Figure out the missing value using exponents.

$$a^{-14} \div a^{-14} = \square$$