Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.

LESSON: THE BIG SHRINK

What command will bring Kyle back to his original size?

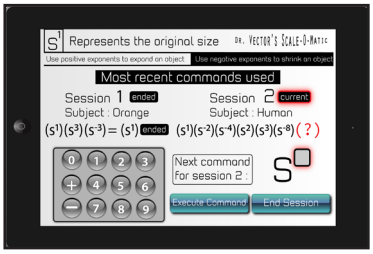
When learning integer exponent rules, it is crucial that students are able to connect the shortcuts to the longhand form, showing they understand why and how the rules work. In *The Big Shrink*, brothers Kyle and Lyle are observing Dr. Lecie Vector test out her Scale-O-Matic, a device that resizes objects using exponents. An exponent of 1 indicates an object is at its original size, while positive exponents cause the object to grow and negative exponents cause the object to shrink. She is currently writing commands to resize an orange. Dr. Vector is momentarily called away, leaving Kyle and Lyle with the device. Kyle convinces Lyle to use the device on him, changing his size. Dr. Vector returns to a very small Kyle begging to be returned to original size. Dr. Vector warns of the extreme side effects, and demands that they use only one more command to return Kyle to original size. The data provided is the device screen showing the commands used on Kyle and an entry box awaiting the final command.

Download the Detailed Lesson Plan
Available on the Teacher Dashboard

The Math Simulator™

1 Immersion

- Play *The Big Shrink Immersion* video, whole-class.
- Restate the question: **What command will bring Kyle back to his original size?**
- Facilitate classroom discussion; ask students: "What do we need to know?"



2 Data & Computation

- Print the *Data Artifact* and distribute to students.
- Allow students work time. Ask students: "Does your answer make sense?"
- Consider using a sharing protocol leading to mathematical insights and/or highlighting misconceptions.
- Allow students to revise their work.

3 Resolution

- Play *The Big Shrink Resolution* video, whole-class.
- Prepare and give brief lecture (*Teacher Instruction*).

+ Simulation Trainer (Use student headphones.)

- Assign the *Simulation Trainer*.
- Use protocols that encourage students to help each other.
- Use *Progress Monitoring* to access real-time data for the classroom.
- Provide individual help for students who are not making progress.

Instruction at a Glance

Gladys Graham

Kevin Simpson

Megan LeBleu

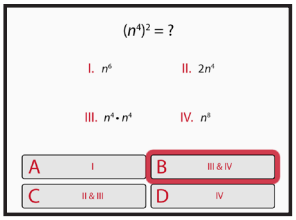
Gladys: Consider using a base of 10 to introduce students to exponent rules, as they've been working with this base since Grade 5. It can help to explain some of the rules which will then be applied to different bases.

Kevin: When showing students exponent rules, write out the expression in longhand form when possible, so students understand the rule and aren't just trying to memorize it. ($n^3 \cdot n^5 = n{\cdot}n{\cdot}n \cdot n{\cdot}n{\cdot}n{\cdot}n{\cdot}n = n^8$, which is why $n^3 \cdot n^5 = n^{3+5} = n^8$.)

Megan: Negative exponents can be difficult to understand. It may help to have students think of them in contrast to positive exponents. Positive exponents ask us to multiply the base a certain number of times. We might think of negative exponents as asking us to divide by the base a certain number of times ($2^{-3} = ½{\cdot}½{\cdot}½ = 1/8$).

Standard Math Procedures

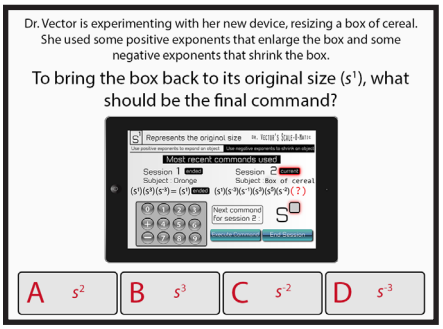
Ex. Clicker Quiz #5

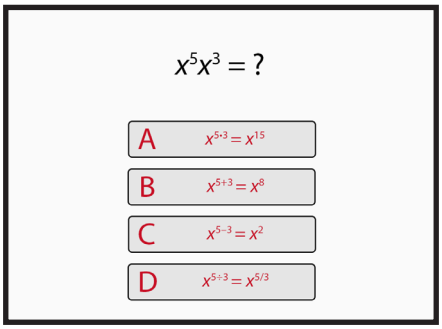


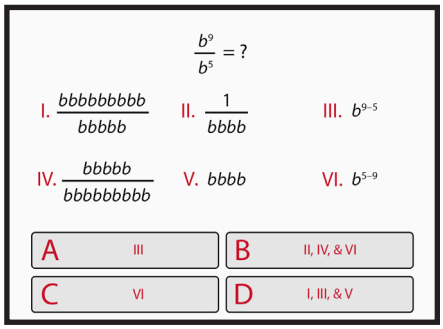
1. Simplify by using the power-to-a-power rule.
   $(n^4)^2 = n^{4 \cdot 2} = n^8$
2. Check by writing out expression longhand.
   $(n^4)^2 = n^4 \cdot n^4 = n{\cdot}n{\cdot}n{\cdot}n{\cdot}n{\cdot}n{\cdot}n{\cdot}n = n^8$
3. Choose equivalent expressions.
   B: III & IV

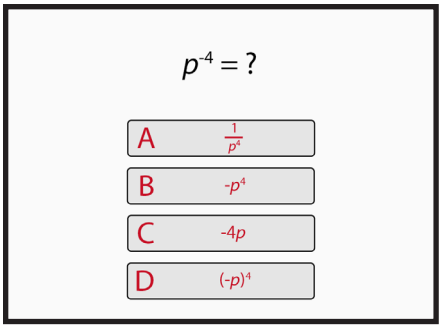
Clicker Quiz

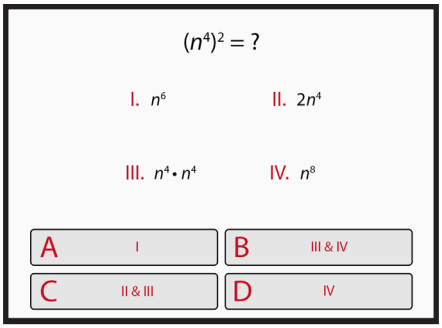
Launch the *Clicker Quiz*, whole-class.

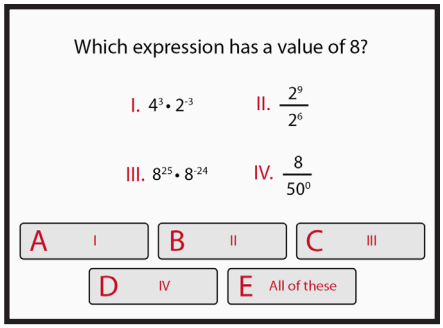












Name _____ Date _____ Period _____

THE BIG SHRINK

What command will bring Kyle back to his original size?

Brothers Kyle and Lyle are again observing Dr. Lecie Vector test out her Scale-O-Matic, a device that resizes objects using exponents. An exponent of 1 indicates an object is at its original size, while positive exponents cause the object to grow and negative exponents cause the object to shrink. She is currently writing commands to resize an orange. Dr. Vector is momentarily called away, leaving Kyle and Lyle with the device. Kyle convinces Lyle to use the device on him, changing his size. Dr. Vector returns to a very small Kyle begging to be returned to original size. Dr. Vector warns of the extreme side effects, and demands that they use only one more command to return Kyle to original size. The data provided is the device screen showing the commands used on Kyle and an entry box awaiting the final command.

8.EE.A.1

About this standard

Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.

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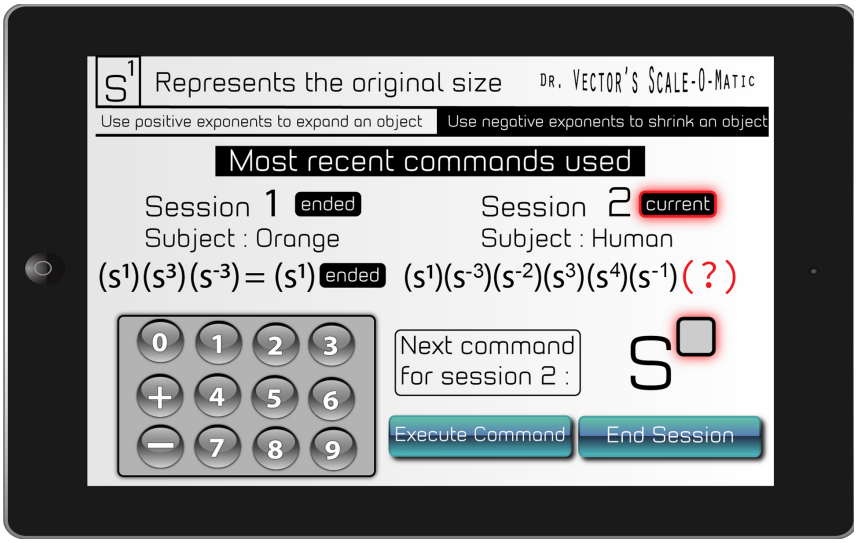

Name _____ Date _____ Period _____

APPLYING THE STANDARD

How might this standard appear on a test?

CHECK OUT MY WORKED EXAMPLE #3F

1) Evaluate the expressions in each table. Follow the pattern when necessary.

a)

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

b)

$\left(\frac{1}{3}\right)^{-3}$	$\left(\frac{1}{3}\right)^{-2}$	$\left(\frac{1}{3}\right)^{-1}$	$\left(\frac{1}{3}\right)^{0}$	$\left(\frac{1}{3}\right)^{1}$	$\left(\frac{1}{3}\right)^{2}$	$\left(\frac{1}{3}\right)^{3}$

2) Complete each table by simplifying the given expression, marking an 'X' in the appropriate answer column.

a)

	p^4	p^2	$2p^2$	$4p^2$	1	$\frac{1}{p}$
$\left(p^2\right)^2$						
$(2p)^2$						
$\frac{p^6}{p^4}$						
$\left(p^4\right)^0$						
$p^2 \cdot p^{-3}$						
$\frac{4p^5}{2p^3}$						

b)

	h	h^2	$2h$	1	$\frac{1}{h}$
$\left(h^0\right)^3$					
$\left(h^2\right)^{-1} \cdot h^3$					
$\frac{h^3}{h^4}$					
$\frac{2h^5}{h^4}$					
$\left(\frac{1}{h}\right)^{-2}$					

3) Simplify.

a) $2^3 \cdot 2^{-3}$

b) $\left(\frac{2}{3}\right)^3$

c) $\frac{(-2)^4}{(-2)^2}$

d) $4^{-2} \cdot 4^4 \cdot 4^0$

e) $\frac{6^0}{6^2}$

f) $2^4 \cdot 2^{-5} \cdot 2^2$

g) $(5^{-2})^2 \cdot 5^{-1}$

h) $\frac{(2^3)^2 \cdot 3^2}{3^3 \cdot 2^4}$

4) Simplify. Write your answer using only positive exponents.

a) $\frac{a^5}{a^2}$

b) $b^{-2}b^7b^{-6}$

c) $(3n)^4$

5) Write an expression that would result in the given answer.

a) z^4

b) $\frac{1}{z^5}$

c) $4z^6$