Exponent Rules

ID: 9188

Time required
25 minutes

Activity Overview

This activity allows students to work independently to discover rules for working with exponents, such as Multiplication and Division of Like Bases and the Power of a Power rule. Students also investigate the value of a power whose exponent is zero or negative. As an optional extension, students investigate the value of a power whose exponent is a fraction with a numerator of one.

Topic: Polynomials

- *Use technology to discover the rules for forms such as* $a^m \cdot a^n$, $\frac{a^m}{a^n}$, *and* $\left(a^m\right)^n$ *for various integer values of m and n and a fixed integer value a.*
- *Use technology to verify for various values of a and n that* $a^{-n} = \frac{1}{a^n}$ *where n is an integer.*
- *Evaluate simple numerical expressions raised to integral exponents (including zero exponents).*
- *Use technology to evaluate more complex numerical expressions involving exponents.*

Teacher Preparation and Notes

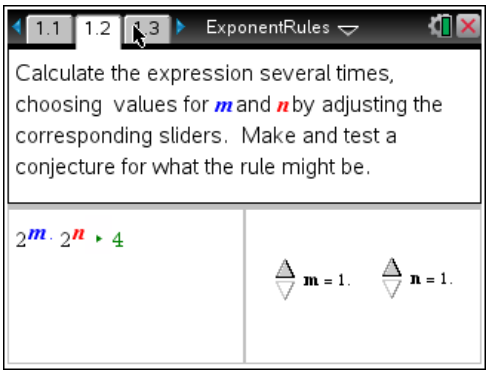
- *This activity is designed to be used in an Algebra 1 classroom. It can also be used in a Pre-Algebra classroom, or by any student learning the rules for operating with exponents.*
- *Students should already be familiar with basic powers, exponents, and bases, such as* $2^3 = 8$.
- *While students can use Scratchpad at any time, you may wish to review the positive powers of two before beginning this activity (2, 4, 8, 16, 32, 64...).*
- *This activity is intended to be mainly* ***student-led****, with breaks for the teacher to introduce concepts or bring the class together for a group discussion. Each student should have his or her own handheld.*
- *Notes for using the TI-Nspire™ Navigator™ System are included throughout the activity. The use of the Navigator System is not necessary for completion of this activity.*
- ***To download the student TI-Nspire document (.tns file) and student worksheet, go to education.ti.com/exchange and enter "9188" in the keyword search box.***

Associated Materials

- *ExponentRules_Student.doc*
- *ExponentRules.tns*

Problem 1 – Discovering exponent rules

On page 1.2, have students evaluate the expression in the lower left pane by selecting various values for *m* and *n* by manipulating the corresponding sliders. (Pressing ctrl+tab will allow students to move between applications in a split window.)



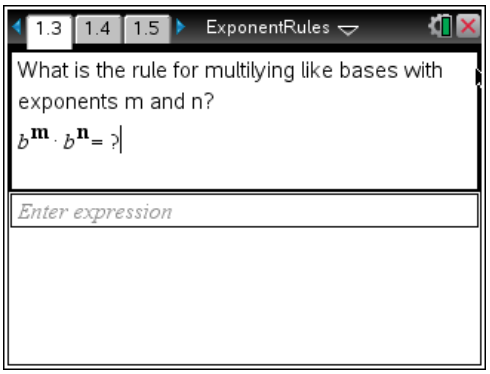
TI-Nspire Navigator Opportunity: *Screen Capture*

See Note 1 at the end of this lesson.

Have students work independently on page 1.3. Perform a Screen Capture to check on students' progress.

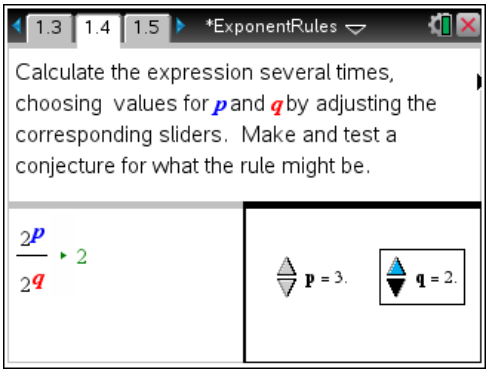
After completing these two pages, encourage students to discuss their findings. Be sure that students observe that these rules apply only when the powers have like bases.

Verify that students have checked the rule for page 1.2, $b^m \cdot b^n = b^{m+n}$, and that it is called the ***Product of Powers*** rule.

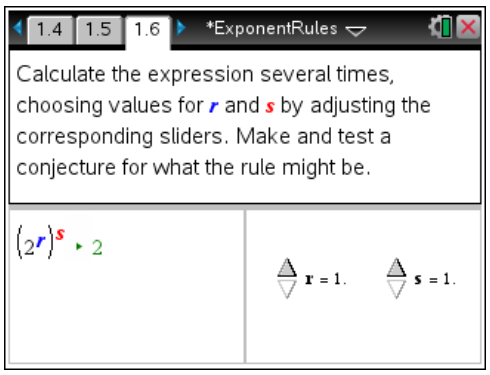


Prompt students to conclude that the rule for page 1.4, $\frac{b^m}{b^n} = b^{m-n}$, is the ***Quotient of Powers*** rule.

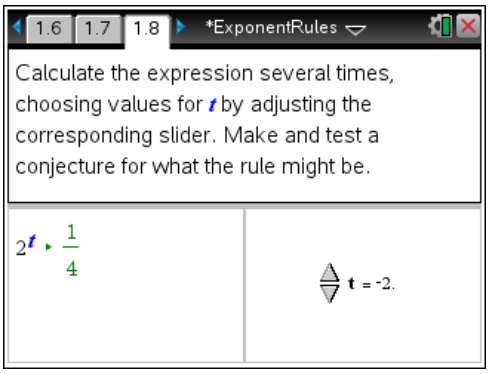
Note: For convenience, the variables *m* and *n* will be used when expressing the Exponent Rules on the question pages in this document. Because of the use of sliders in this activity, several other variables were used on the exploration pages.



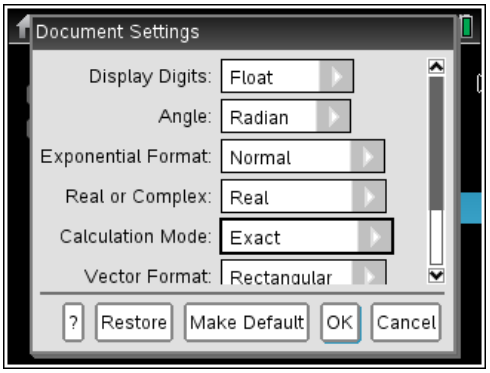
Repeat a similar process for the rule on page 1.6, $\left(b^m\right)^n = b^{m \cdot n}$, known as the ***Power of a Power*** rule.



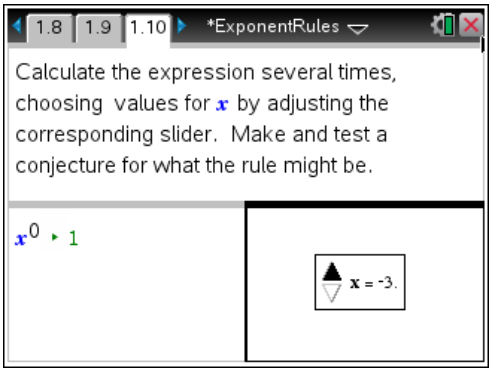
Students continue working independently through pages 1.8 to 1.11, which allows them to explore negative and zero powers, respectively. Be sure they draw the correct conclusions, namely that $b^{-m} = \frac{1}{b^m}$ and $b^0 = 1$ (for $b \neq 0$ and m a positive integer).



Note: If students are having difficulty trying to find fraction representations of their decimal results on page 1.8, they may find it helpful to change their calculator's settings to allow for this. This can be done by selecting on > **Settings > Document Settings** and changing Calculation Mode to "Exact." Next, select Make Default.



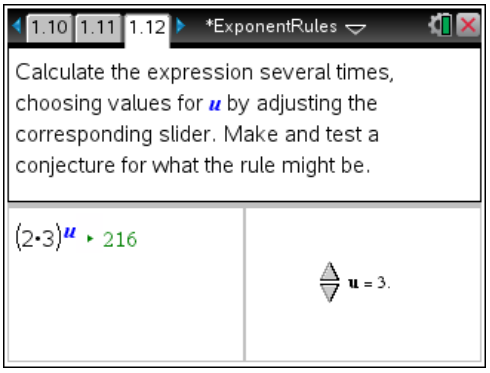
On page 1.10, it is important that students observe 0^0 is considered undefined by the calculator.



TI-Nspire Navigator Opportunity: *Quick Poll*

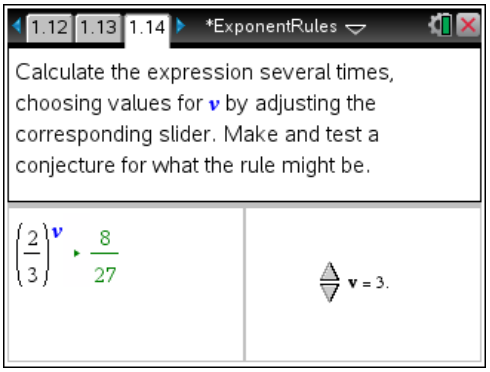
See Note 2 at the end of this lesson.

Students finish the activity by completing pages 1.12 through 1.15.



Page 1.12 has students explore the ***Power of a Product*** rule: $(a \cdot b)^m = a^m \cdot b^m$ …

…whereas on page 1.14 they explore the ***Power of a Quotient*** rule: $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$, where $b \neq 0$.



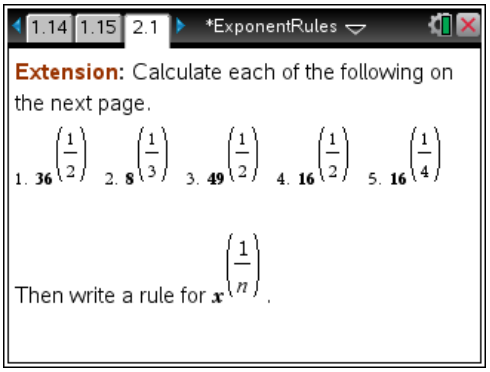
Again, on page 1.14, students may find it helpful to have their handheld's Calculation Mode set to Exact.

Problem 2 – Extension: Rational Exponents with Numerator of 1

Page 2.1 asks students to evaluate the five expressions shown to make a conjecture for $x^{\frac{1}{n}}$.

They will see that $x^{\frac{1}{n}} = \sqrt[n]{x}$.

You may need to explain that when $n = 2$, the '2' is usually omitted: $\sqrt{\ } = \sqrt[2]{\ }$.



TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 3 at the end of this lesson.

Note 1

Problem 1, *Screen Capture*

This would be a good time to do a screen capture to verify students are manipulating the sliders correctly and maneuvering through the document at a reasonable pace.

Note 2

Problem 1, *Quick Poll*

You may choose to use Quick Poll to assess student understanding. You may ask the students to evaluate 1000^0.

Note 3

Problem 2, *Quick Poll*

You may choose to use Quick Poll to assess student understanding. You may ask the students to evaluate $125^{\frac{1}{3}}$ or write an equivalent expression in radical form for $x^{\frac{1}{5}}$.