DEFINING EXPONENTS

This lesson introduces a lot of new concepts, and it is only possible to meet all learning goals if enough time is dedicated to forming a solid foundation of how exponents work. Students should learn how to name the base and exponent in a power, and to use correct language to describe exponents and their operations. Before moving on to exponent operations and laws, give students plenty of practice converting between exponent and expanded forms, and evaluating exponents. Define $2^1 = 2$. Avoid teaching about zero exponents at this time.

COMMON MISCONCEPTIONS

1. $2^5 = 2 \times 5$

If students don’t have enough practice working with powers and exponents, they can quickly forget the meaning of the exponent and default to multiplying the numbers that they see. Give students plenty of opportunities to identify “what not to do” scenarios. Ensure that they know the function of the base and of the exponent. Have students practice using correct language for exponents: “two to the power of five” or “two raised to the fifth power” are correct, but students who rush through processes may say “two five.” Language is important, and their word choice reflects students’ understanding of the concepts.

2. To multiply powers, you multiply the exponents.

This is likely the most common mistake that students make when practicing exponent laws. Since this lesson is students’ first formal introduction to exponents, ensure that they have plenty of practice evaluating exponents and converting between exponent form and expanded form before moving on to operations with exponents. This is the foundation for understanding all exponent laws, and if students use the wrong operations for exponents, have them work through how the exponent law for multiplying powers with the same base is derived.

3. $2^3 \times 4^2 = (2 \times 4)^3 + 2$ or $2^3 + 2^4 = 2^3 + 4$

If students read too quickly or do not understand concepts thoroughly, they may try to apply exponent laws to powers with different bases, or where the operation is not multiplication or division. As usual, when you or the student notices that their answer is incorrect, have them check their work by expanding. Expanding to check answers is a worthwhile habit to form, especially while these laws are new to students.
EXPONENT LAWS

Students learn the basic laws for operations with exponents: to multiply powers with the same base, add the exponents; to divide powers with the same base, subtract the exponents; and to raise a power to a power, multiply the exponents. Exponent laws can be simple to use, but remembering them and using them is not necessarily an indicator of understanding. If possible, students should have an opportunity to discover the laws on their own by working through several examples and observing patterns. Then ask students to prove the answers that they found using exponent laws by expanding expressions to show that they obtain the same answer. While exponent laws are fairly easy to remember, they can also be easy to forget. Students should focus on remembering how to derive exponent laws, which relies on a strong foundation of how exponents work.

ORDER OF OPERATIONS

Once students are comfortable using exponent laws, give them more challenging expressions that combine their preexisting knowledge of the order of operations with their new understanding of exponents. Students know GMS (Groupings, Multiplication and division from left to right, Subtraction and addition from left to right) which now becomes GEMS to include Exponents. Give students problems that ensure they can distinguish when to use exponent laws: when the powers have the same base and the operation is multiplication only. When students are given expressions with many operations, they are more likely to misuse exponent laws, so make sure they have plenty of practice.

TEACHER TIPS

This is a challenging lesson that should progress gradually, ensuring that students are well prepared for each subsequent piece. Keep practice questions simple and increase difficulty only when students are ready. If exponent laws are introduced before students can define exponents with confidence, they simply memorize the laws without learning why they work. Do not introduce the zero exponent in this lesson and be careful to avoid division questions that result in a higher degree in the denominator, or a negative exponent in the numerator. These concepts will be taught later. Note that sometimes wording can be tricky. Often when referring to exponents, we say “4 multiplied by itself 5 times” to mean $4^5$. If you use this wording, be sure to clarify that 4 is multiplied a total of 5 times ($4 \times 4 \times 4 \times 4 \times 4$), and **not** that an initial 4 is subsequently multiplied by 4 an additional 5 times ($4 \times 4 \times 4 \times 4 \times 4 \times 4$).