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Multiplication and division of exponents worksheet pdf

Multiplying exponents with the same base and different bases involves the application of identities. We generalize the properties of exponents and arrive at the identities. Multiplying Exponents With the Same Base Consider am × an , where 'a' is the common base and 'm' and 'n' are the exponents. When we multiply two exponential terms with the same base we get: 22 × 23 = (2 ×2) × (2 × 2 × 2) = 25. We will get the same result if we add the exponents. 22 × 23 = 2 (2 + 3) = 25. Thus we conclude that: Note that this property will apply for the multiplication of any number of exponential terms with the same base: \({a^{{p_1}}} \times {a^{{p_2}}} \times {a^{{p_3}}} \times ... = {a^{\left\{ {{p_1} + {p_2} + {p_3} + ...} \right\}}}\) Let us consider multiplying exponents with different bases and the same exponent, as in the case of am × bm. For example, let us take: 114 × 34 114 = 11 × 11 × 11 × 11 and 34 = 3 × 3 × 3 × 3 114 × 34 = (11 × 11 × 11 × 11) × (3 × 3 × 3 × 3) = 11 × 3 × 11 × 3 × 11 × 3 × 11 × 3 = 33 × 33 × 33 × 33 = 334. This can also be written and solved as: 114 × 34 = (11 ×3)4 = 334. Therefore, when we multiply exponents with different bases and the same exponent, we apply the identity: Dividing Exponential Terms Consider am ÷ an , where 'a' is the common base and 'm' and 'n' are the exponents. Now, let us divide two exponential terms which have the same base: 37÷ 34. 37 =3 × 3 × 3 × 3 × 3 × 3 × 3 and 34 = 3 × 3 × 3 × 3 37 ÷ 34 = \(\dfrac{3 × 3 × 3 × 3 × 3 × 3 × 3}{3 × 3 × 3 × 3}\)= 33 This can also be written and solved as: 37 ÷ 34 = 3 (7-4) = 33. Note that while dividing exponential terms, if the bases are the same, we find the difference of the exponents. Hence, the identity which is used here is: Dividing Exponents With Different Base And Same Exponent Consider am ÷ bm , where the exponents have different bases and the same exponent. For example, let us solve: 123 ÷ 33. 123 = 12 × 12 × 12 and 33 = 3 × 3 × 3 123 ÷ 33 = (12 ÷ 3)3 = 43 This can be concluded as 123 ÷ 33 = (12÷3)3 = 43. Hence, while dividing exponents with different bases and the same exponent, we apply the identity: How to Multiply and Divide Fractional Exponents? Before understanding how to multiply or divide the fractional exponents with the same base, let's see some examples of fractional exponents with the same base. \(2^ \frac{3}{2}\) , \(2^ \frac{1}{4}\) , \(2^ \frac{-4}{5}\) Multiplying Fractional Exponents With the Same Base Consider 2½ × 2¾ = 2(½ + ¾) = \(2^\frac{5}{4}\). Here, we have applied the identity am × an = am+n Dividing Fractional Exponents With the Same Base Consider \(3^ \frac{3}{2} \div 3^\frac{1}{2} = 3^{(\frac{3}{2} - \frac{1}{2})}\) = 31 = 3. Here, we have applied the identity am ÷ an = am-n How to Multiply and Divide Exponents With Variables? The identities which are used in numbers are also used in exponents with variables. Let us recollect them and then use them in the following examples: am × an = am+n am × bm = (a ×b)m am ÷ an = am-n am ÷ bm = (a ÷ b)m Variable as the Base Let us see how to use the identities when the base is a variable. For example, solve: y2 × (2y)3 We will apply the identity: am × bm = (a × b)m , y2 × (2y)3 = y2 × 23 × y3 = 23 × y(2+3) = 8y5 Variable as the Exponent Let us see how to use the identities when the exponent is a variable. For example, solve:5(2x -1) ÷ 5(x + 1) We will apply the identity: am ÷ an = am-n , we get 5(2x -1 - x - 1) = 5(x -2) Related Topics Example 1: Solve: 32 × 92 Solution: Applying the identity, am × bm = (a × b)m 32 × 92 = 272 = 729 Example 2: Find the value of the expression 3(a4b3)10 × 5(a2b2)3 Solution: 3(a4b3)10 × 5(a2b2)3 = 3 × a40 × b30 × 5 × a6 × b6 (Applying the identity, (am)n = amn) = 3 × 5 × a40 × a6 × b30 × b6 = 15× a(40+6) × b(30+6) (Applying the identity, am × an = am+n) = 15× a46 × b36 = 15 a46 b36 Example 3: Find the value of the expression \(\dfrac{a^{(n-2)}}{a^{(2n-4)}}\) Solution: \(\dfrac{a^{(n-2)}}{a^{(2n-4)}}\) = a(n - 2- 2n + 4) (Applying the identity,am ÷ an = am-n) = a(n-2-2n+4) = a (2-n) Get Solutions > go to slidego to slidego to slide FAQs on Multiplying And Dividing Exponents To divide the numbers or variables with the same base, we apply the identity: am ÷ an = am-n To divide the numbers or variables with different bases, we apply the identity: am ÷ bm = (a ÷ b)m How do You Solve Exponents in Parentheses? The exponents inside parentheses can be solved using the identity (am) n = amn. For example, (42)3 = 4(2 × 3) = 46 = 4096 Can You Multiply Exponents With Different Coefficients? Yes, we can multiply exponents with different coefficients. For example, 2y2 × 3y = 2 × 3 × y(2+1) = 6y Can we Distribute Exponents Over Division? Yes, we can distribute exponents over division. For example, (7/2) 3 = 73 ÷ 23 = 343/8 How to Multiply and Divide Negative Exponents? When we multiply and divide negative exponents, we follow the same identities that we use for positive exponents. For example, we use the identity: am ÷ an = am-n to solve: 2-3/2-4. This will be: 2(-3-(-4)) = 2(-3 + 4) = 21 = 2. Observe the rule of simplification of integers which changes the sign after the brackets are opened. It should also be noted that the negative sign on an exponent means the reciprocal of the number. For example, 7-3 can also be written as: 1/73. Practice exponents worksheets mixing exponents with simple multiplication. Again, these are fantastic exercises for enhancing student comprehension of basic order of operations concepts where exponents are involved.Multiplying ExponentsThis set of exponents worksheets provide practice multiplying simple exponential terms against numbers. These worksheets provide a gentle introduction into working with exponents in otherwise typical multiplication problems, and help reinforce the order of operation rules necessary to solve more complex problems later. Are you ready to become a master of dividing exponents?(Need help with Negative Exponents, click here for our super easy 3-step explanation)Let's start with the following key question about dividing exponents: How can you divide powers (or exponents) with the same base?Note that the following method works when the base is either a number or a variable (the following lesson guide will show examples of both)Let's start with a simple example: what is 5^7 divided by 5^4? Start by rewriting the fraction in expanded form as follows (you won't have to do this every time, but we'll do it now to help you understand the rule, which we'll get to later.) Notice how there are repeat values in the numerator and the denominator.Since any non-zero value divided by itself is equal to one, you can cancel out these repeats as follows: Doing this allows you to rewrite the above fraction in simplified form, as follows:Finally, you can rewrite 5 x 5 x 5 as 5^3 and you have finished the problem. 5^7 divided by 5^4 equals 5^3 Did you notice a relationship between all of the exponents in the example above? Notice that 5^7 divided by 5^4 equals 5^3. Also notice that 7 - 4 = 3This relationship applies to dividing exponents with the same base whether the base is a number or a variable:Whenever you divide two exponents with the same base, you can simplify by subtracting the value of the exponent in the denominator by the value of the exponent in the numerator. Here are a few examples applying the rule: This Algebra 1 - Exponents Worksheet produces problems for working with Exponents with Multiplication and Division. Click here for More Algebra 1 - Exponents Worksheets Exponentiation is a mathematical operation involving two numbers, the base x and the exponent a. When a is a positive integer, exponentiation corresponds to repeated multiplication of the base. For example, if the base is $x=2$ and the exponent $a=3$, it is writen as $x^a=2^3$. This means that we have multiplied the number 2 by itself three times or: $2\cdot{2}\cdot{2}$, which equals 8. By definition, every number which has 0 as its exponent is equal to 1. This means that, no matter how large is the base, if their exponent is equal to 0, that number is always equal to 1. Every number that doesn't have an exponent attached to it, actually has the number 1 as its exponent. The number 1 is the default exponent of every number, so it isn't necessary to write it down, but in some tasks it can be helpful to do so. One multiplied by one is always one, no matter how many times you repeat the multiplication, so 1 to any power is always equal to 1. Negative exponents If the exponent is a positive integer, exponentiation corresponds to repeated multiplication of the base, so what does it mean if the exponent is a negative integer? The reciprocal value of the base is than used to turn the negative exponent into a positive. $a^{-n}=(a^{-1})^n=\left(\frac{1}{a}\right)^n=\frac{1}{a^n}$ The same goes the other way around. If an unknown is in the denominator, the denominator can become a numerator by changing the sign of the exponent. In some cases, this will prove to be a very useful feature, especially when working with inverse numbers and functions. Example 1: Write these expressions using only positive exponents: a) a^{-7} b) $\frac{-6x^{-1}}{y^5}$ c) $\frac{-12x^{-6}y^{-9}}{z^3}$ Solution: a) $a^{-7}=\frac{1}{a^7}$ b) $\frac{-6x^{-1}}{y^5}=\frac{-6}{xy^5}$ c) $\frac{-12x^{-6}y^{-9}}{z^3} = \frac{-12}{x^6 \cdot y^9 \cdot z^3}$ Addition How does one add or subtract exponents? For example, $\ 2^2 = 4$ and $\ 2^3 = 8$ so $\ 4 + 8 = 12$. But for $\ 2^2 + 2^3$, the answer is not that obvious. One cannot add nor subtract numbers that have different exponents or different bases. Most interesting tasks involve unkowns, but the same rules apply to them. Let's look at a simple equation: $\ x + 2 + 3x = 1$ Since $\ x = x^1$ and $\ 1 = x^0$ we can write our equation like this: $\ x^1 + 2 \cdot {x^0} + 3 \cdot {x^1} = 1 \cdot {x^0}$ How would you normally solve it? The variables with x are added separately, and separately variables without x. The same will apply to larger exponents: $\ x^{12} + 2 \cdot{x^2} + 3 \cdot {x^{12}}= ?$ $\ x^{12} + 3 \cdot {x^{12}} + 2 \cdot {x^2} = 4 \cdot {x^{12}} + 2 \cdot {x^2}$The variables with the same exponents are grouped. Example 2: Add exponents $\ 2 \cdot {x^3} + 3 \cdot {x }+ 0.5\cdot {x^2} + x^1 + 2 \cdot {x^7} + 3 \cdot {x^3} = ?$$\ 2x^7 + (2 \cdot {x^3} + 3 \cdot {x^3}) + 0.5 \cdot {x^2} + (3x + x) = 2x^7 + 5x^3 + 0.5 \cdot {x^2} + 4x$ Subtraction The same rules that apply to adding exponents, apply to subtracting as well. You can only subtract numbers that have unknowns with the same exponent. Example 3: Subtract exponents: $ 4x^{12} – 0.25 x^4 + 2x^2 – 3x^2 – 3x^{12} = ?$ Solution: $ (4x^{12} – 3x^{12}) – 0.25\cdot {x^4} + (2x^2 – 3x^2) = x^{12} – 0.25\cdot {x^4} – x^2$ Multiplication There are two basic rules for multiplication of exponents. The first rule – if bases are the same, their exponents are added together. For example: $\ 2^2 \cdot {2^3} = 2^{2 + 3} = 2^5$. Similarly, with a negative exponent, it can either be left as it is, or transformed into a reciprocal fraction. For example: $\ 2^{-2} \cdot {2^{-3}} = 2^{- 2 – 3} = 2^{-5} = \left(\frac{1}{2}\right)^5$. The second rule – if bases are different, but exponents are the same, bases are multiplied and exponents remain the same. For example: $\ 2^2 \cdot {3^2} = (2 \cdot {3})^2 = 6^2$. Example 4: $ 2^2 \cdot {4^2} = ?$ Solution: To multiply two exponents, their base or their exponents must be the same. In this example, neither is the case. So, the first step is to, whenever possible, to turn every number to the lowest base. In this example the number 4 can be written as 2^2. $ 2^2 \cdot {(2^2)^2} = ?$ The square represents the number multiplied by itself so $\ (2^2)^2$ can be written as $\ 2^2 \cdot {2^2} = 2^{2 + 2} = 2^4$. From Example 4, this generalisation can be made: Final solution: $\ 2^2 \cdot {4^2}= 2^2 \cdot {(2^2)^2} = 2^2 \cdot {2^4} = 2^{2+4} = 2^6$. Example 5: $ \left(\frac{2}{3}\right)^2 \cdot {0.2^2} = ?$ Solution: $$=\left (\frac{2}{3}\right)^2 \cdot \left (\frac{2}{10}\right)^2$$ $$=\left (\frac{2}{3}\right)^2 \cdot\left (\frac{1}{5}\right)^2$$ $$= \left(\frac{2}{3} \cdot \frac{1}{5}\right)^2 $$ $$= \left(\frac{2}{15}\right)^2$$ Example 6: $\ (x^2 y^3) (x^5 y^4)$ Solution: Multiplication is associative so the order of brackets doesn't make a difference. The factors with the same bases are multiplied as explained before, so their exponents are added. $ (x^2 \cdot y^3)(x^5 \cdot y^4) = x^2 \cdot x^5 \cdot y^3 \cdot y^4 = x^7 \cdot y^7 = (xy)^7$ Division As for multiplication, there are two basic rules for dividing exponents. The first rule – when bases are the same, their exponents are subtracted. For example: $\ 2^2 : 2 = \frac{2^2}{2} = 2^{2 – 1} = 2^1 = 2$, which can easily be checked since $4 : 2 = 2$. For example: $\ 2^{-2} : 2^{-1} =\frac{2^{-2}}{2^{-1} }= 2^{-2-(-1)} = 2^{-1} = \frac{1}{2}$. The second rule – if bases are different, but exponents are the same, bases are divided and the exponents remain the same. For example: $\ 2^2 : 3^2 = \frac{2^2}{3^2 } = (2 : 3)^2 = \left(\frac{2}{3}\right)^2$. Example 7: $\frac{4^2}{4^3} + \frac{1}{2} = ?$ Solution: $\frac{4^2}{4^3} + \frac{1}{2} = 4^{2 – 3} + \frac{1}{2} = 4^{-1} + \frac{1}{2} = \frac{1}{4} + \frac{1}{2} = \frac{1 + 2}{4} = \frac{3}{4}$ Example 8: $\frac{4^5}{4^{-2}} – 0.2 \cdot {4} + \frac{1}{2} \cdot {2^8} = ?$ Solution: $\frac{4^5}{4^{-2}} – 0.2 \cdot 4 + \frac{1}{2} \cdot 2^8 = 4^{5 – (-2)} – \frac{2}{10} \cdot 4 + \frac{2^8}{2^1} = 4^{5 + 2} – \frac{1}{5} \cdot 4 + 2^{8 – 1} = 4^7 – \frac{4}{5} + 2^7$ Example 9: $\frac{18x^5y^6a^2}{6xy^2a^5} = ?$ Solution: $\frac{18x^5y^6a^2}{6xy^2a^5} = 3x^{5 – 1}y^{6 – 2}a^{2 – 5} = 3x^4y^4a^{-3} = \frac{3x^4y^4}{a^3}$ If, like in this example, a task involves only division and multiplication, the fraction can be divided into two smaller fractions. $\frac{x^2y^3 + x^5y}{xy} = \frac{x^2y^3}{xy} + \frac{x^5y}{xy} = xy^2 + x^4$ Exponents worksheets Properties of exponents Numeric expressions (312.6 KiB, 2,049 hits) Algebraic expressions (450.1 KiB, 2,031 hits) Basics of exponents Scientific notation (166.4 KiB, 1,707 hits) Scientific notation - Write in standard notation (187.0 KiB, 1,436 hits) Operations with exponents Multiplication (195.3 KiB, 2,004 hits) Division (197.0 KiB, 1,754 hits) Raised to a power (174.1 KiB, 1,915 hits)

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