

Exponents and Powers of Rational Numbers

Name: _____

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An **exponent** is simply a shorthand that says “multiply this base by itself this many times”—so b^n means b multiplied by itself n times. In Grade 7 you will push this idea further by applying exponents to fractions, decimals, and negative numbers. Watch the signs carefully: a negative base with an *even* exponent gives a positive result, while an *odd* exponent keeps it negative—for example, $(-2)^4 = 16$ but $(-2)^3 = -8$. Two special cases are worth memorizing: any non-zero number to the power of 0 equals 1, and anything to the power of 1 is just itself. Master exponents now and you will be ready for scientific notation, order of operations, and algebra!

Key Concepts & Quick Review

Definition: $b^n = \underbrace{b \times b \times \dots \times b}_{n \text{ factors}}$

Special cases: $b^1 = b$ $b^0 = 1$ (for any $b \neq 0$)

Negative base, even exponent \Rightarrow positive: $(-3)^2 = 9$

Negative base, odd exponent \Rightarrow negative: $(-3)^3 = -27$

Fraction base: $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$ Example: $\left(\frac{2}{3}\right)^3 = \frac{8}{27}$

Decimal base: $(0.4)^2 = 0.4 \times 0.4 = 0.16$

Examples

① Evaluate $\left(-\frac{1}{2}\right)^4$.

Think It Through: The base is $-\frac{1}{2}$ and it is raised to the 4th power. Since the exponent is **even**, the result is positive. $\left(-\frac{1}{2}\right)^4 = \frac{(-1)^4}{2^4} = \frac{1}{16}$.

Answer: $\frac{1}{16}$

② Evaluate $(-2)^3 + (0.5)^2$.

Think It Through: $(-2)^3 = -8$ (odd exponent \Rightarrow negative). $(0.5)^2 = 0.25$. Add: $-8 + 0.25 = -7.75$.

Answer: -7.75




Practice Problems

Evaluate each expression.



- | | | | |
|------------------------------------|-------|------------------------------------|-------|
| 1. $3^4 =$ | _____ | 8. $\left(-\frac{1}{2}\right)^5 =$ | _____ |
| 2. $(-5)^2 =$ | _____ | 9. $(0.3)^2 =$ | _____ |
| 3. $(-2)^5 =$ | _____ | 10. $(0.1)^4 =$ | _____ |
| 4. $(-1)^{10} =$ | _____ | 11. $(-0.2)^3 =$ | _____ |
| 5. $\left(\frac{1}{3}\right)^3 =$ | _____ | 12. $(1.5)^2 =$ | _____ |
| 6. $\left(\frac{2}{5}\right)^2 =$ | _____ | 13. $(-4)^3 =$ | _____ |
| 7. $\left(-\frac{3}{4}\right)^2 =$ | _____ | 14. $2^6 =$ | _____ |
| | | 15. $\left(\frac{5}{6}\right)^2 =$ | _____ |

Study Tips

-  Watch the parentheses! $(-3)^2 = 9$ but $-3^2 = -9$. The parentheses tell you the **entire** negative number is the base.
-  For fraction bases, raise both the numerator **and** denominator to the power separately.
-  Any non-zero number raised to the 0 power equals 1.

Word Problems

16. A bacterial culture doubles every hour. If the culture starts with 1 cell, the number of cells after h hours is 2^h . How many cells are in the culture after 8 hours? After 10 hours? _____
17. A ball is dropped from a height of 1 m. After each bounce it reaches $\frac{3}{4}$ of its previous height. Write an expression using an exponent for the height after the 3rd bounce and evaluate it. What is the height after the 4th bounce? _____



Answer Keys

- | | |
|--------------------|--|
| 1) 81 | 10) $\frac{1}{10000}$ |
| 2) 25 | 11) $-\frac{1}{125}$ |
| 3) -32 | 12) $\frac{9}{4}$ |
| 4) 1 | 13) -64 |
| 5) $\frac{1}{27}$ | 14) 64 |
| 6) $\frac{4}{25}$ | 15) $\frac{25}{36}$ |
| 7) $\frac{9}{16}$ | 16) 256 after 8 hours; 1,024 after 10 hours |
| 8) $-\frac{1}{32}$ | 17) 3rd bounce $\frac{27}{64} m$; 4th bounce $\frac{81}{256} m$ |
| 9) $\frac{9}{100}$ | |

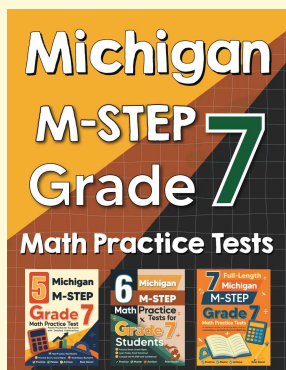
Step-by-Step Explanations

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