Exponents and Powers of Rational Numbers

Name: _____	Date: _____	Score: _____ / 17

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

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

Negative base, even exponent ⇒ positive: $(-3)^2 = 9$
Negative base, odd exponent ⇒ negative: $(-3)^3 = -27$

Fraction base: $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$ $\quad$ 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 ⇒ negative). $(0.5)^2 = 0.25$. Add: $-8 + 0.25 = -7.75$.

Answer: -7.75

Practice Problems

Evaluate each expression.

1. $3^4 =$ _____
2. $(-5)^2 =$ _____
3. $(-2)^5 =$ _____
4. $(-1)^{10} =$ _____
5. $\left(\frac{1}{3}\right)^3 =$ _____
6. $\left(\frac{2}{5}\right)^2 =$ _____
7. $\left(-\frac{3}{4}\right)^2 =$ _____
8. $\left(-\frac{1}{2}\right)^5 =$ _____
9. $(0.3)^2 =$ _____
10. $(0.1)^4 =$ _____
11. $(-0.2)^3 =$ _____
12. $(1.5)^2 =$ _____
13. $(-4)^3 =$ _____
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
2) 25
3) -32
4) 1
5) $\frac{1}{27}$
6) $\frac{4}{25}$
7) $\frac{9}{16}$
8) $-\frac{1}{32}$
9) $\frac{9}{100}$
10) $\frac{1}{10000}$
11) $-\frac{1}{125}$
12) $\frac{9}{4}$
13) -64
14) 64
15) $\frac{25}{36}$
16) 256 after 8 hours; $1{,}024$ after 10 hours
17) 3rd bounce $\frac{27}{64}\ m$; 4th bounce $\frac{81}{256}\ m$

Step-by-Step Explanations

Tutoring notes not found for this topic.

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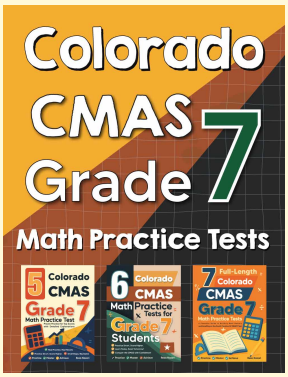

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