

# 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

*Tutoring notes not found for this topic.*



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