

Chapter 9 — Powers and Exponents

Teacher Chapter-at-a-Glance

Materials

No special materials required. A place-value chart may help connect powers of 10 to decimal positions.

Talk Prompt

Display 5^3 and ask whether it means 5×3 or $5 \times 5 \times 5$. Require students to defend the meaning before calculating.

If Ready-to-Learn Reveals a Gap

Rebuild repeated multiplication and BEDMAS before same-base rules if Ready-to-Learn reveals a gap. Expand several powers and check them against the order of operations.

Mastery Decision Guide

What a missed Tripwire item actually means, and what to do about it before moving on.

Missed Tripwire #1 → Ignoring brackets with negative bases (Mistake 3). *A student gives the same answer for both expressions signals this error.* Review before the next chapter.

Missed Tripwire #2 → Combining exponents when bases differ (Mistake 4). *A student changes $2^3 \times 3^2$ into one power signals this error.* Review before the next chapter.

Ready-to-Learn Check

Quick check before starting. A wrong answer below points to a specific gap worth closing first, not just a miss to shrug off.

1. Calculate: $6 \times 6 \times 6$

Correct answer: 216

Likely wrong answer: 18

Misconception: Does not recognize repeated multiplication as multiplication of equal factors.

Next move: Calculate one multiplication at a time: $6 \times 6 = 36$, then $36 \times 6 = 216$.

2. Which expression means $4 \times 4 \times 4 \times 4$?

Correct answer: 4^4

Likely wrong answer: 4×4 or 4^3

Misconception: Counts multiplication signs instead of factors.

Next move: Count how many times the base appears as a factor.

3. Evaluate: $18 - 2^3$

Correct answer: 10

Likely wrong answer: 256

Misconception: Does not apply the exponent before subtraction.

Next move: Use BEDMAS. Exponents are completed before subtraction.

4. Evaluate: $-3 + 8$

Correct answer: 5

Likely wrong answer: -11

Misconception: Needs reinforcement with different-sign integer addition.

Next move: Subtract sizes and keep the sign of the larger value.

Common Mistakes

Students often run into the same kinds of trouble with this topic. Recognizing these patterns helps avoid them.

Comparing 0.86 and 0.809 by Place Value

	Ones		Tenths	Hundredths	Thousandths
0.86	0	.	8	6	0
0.809	0	.	8	0	9

Ones tie. Tenths tie. Hundredths decide it: $6 > 0$, so $0.86 > 0.809$.

-6^2 and $(-6)^2$ use the same digits but different bases.

Mistake 1: Multiplying the base by the exponent

What students do: Evaluating 5^3 as $5 \times 3 = 15$.

Why this happens: The exponent is written beside the base and can look like ordinary multiplication.

What to do instead: Expand the power. The exponent tells how many times the base appears as a factor.

Diagnostic trigger: A student gives 15 for 5^3 signals this error.

Mistake 2: Thinking a zero exponent gives zero

What students do: Evaluating 9^0 as 0.

Why this happens: Students focus on the zero rather than the exponent rule.

What to do instead: Every non-zero base raised to zero equals 1.

Diagnostic trigger: A student gives 0 for a non-zero base with exponent 0 signals this error.

Mistake 3: Ignoring brackets with negative bases

What students do: Treating -6^2 and $(-6)^2$ as the same expression.

Why this happens: The negative sign looks similar in both forms, but brackets change the base.

What to do instead: Identify the base before calculating.

Diagnostic trigger: A student gives the same answer for both expressions signals this error.

Mistake 4: Combining exponents when bases differ

What students do: Simplifying $2^3 \times 3^2$ as one power.

Why this happens: Students remember "add the exponents" but do not check the bases first.

What to do instead: Combine exponents only when the bases match.

Diagnostic trigger: A student changes $2^3 \times 3^2$ into one power signals this error.

Mistake 5: Adding exponents across addition

What students do: Simplifying $4^2 + 4^3$ as 4^5 .

Why this happens: The same-base multiplication rule is applied to addition by mistake.

What to do instead: Add exponents only when same-base powers are multiplied, never when they are added.

Diagnostic trigger: A student writes $4^2 + 4^3 = 4^5$ signals this error.

Practice

Teacher solutions follow this practice set.

1. Identify the base and exponent in 8^5 .
2. Write 6^3 in expanded form.
3. Evaluate: 2^6
4. Evaluate: 10^4
5. Evaluate: 7^0
6. Evaluate: -5^2
7. Evaluate: $(-4)^3$
8. Simplify: $3^4 \times 3^2$
9. Simplify: $6^7 \div 6^4$
10. Simplify: $(2^5)^2$
11. Explain why $2^3 \times 3^2$ cannot be simplified as one power.
12. Evaluate: $4 + 2^3 \times 3$

Practice Solutions

Use these concise solutions to check the method as well as the final answer.

1. Identify the base and exponent in 8^5 .

Solution: In 8^5 , the base is 8 and the exponent is 5.

2. Write 6^3 in expanded form.

Solution: $6^3 = 6 \times 6 \times 6$.

3. Evaluate: 2^6

Solution: $2^6 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$.

4. Evaluate: 10^4

Solution: $10^4 = 10 \times 10 \times 10 \times 10 = 10,000$.

5. Evaluate: 7^0

Solution: $7^0 = 1$ because every nonzero base raised to the zero power equals 1.

6. Evaluate: -5^2

Solution: $-5^2 = -(5^2) = -25$; the exponent applies to 5 before the negative sign is applied.

7. Evaluate: $(-4)^3$

Solution: $(-4)^3 = (-4)(-4)(-4) = -64$.

8. Simplify: $3^4 \times 3^2$

Solution: $3^4 \times 3^2 = 3^{4+2} = 3^6 = 729$.

9. Simplify: $6^7 \div 6^4$

Solution: $6^7 \div 6^4 = 6^{7-4} = 6^3 = 216$.

10. Simplify: $(2^5)^2$

Solution: $(2^5)^2 = 2^{5 \times 2} = 2^{10} = 1,024$.

11. Explain why $2^3 \times 3^2$ cannot be simplified as one power.

Solution: The bases 2 and 3 are different, so the same-base exponent rules do not apply; evaluate the factors separately if a numerical value is required.

12. Evaluate: $4 + 2^3 \times 3$

Solution: $4 + 2^3 \times 3 = 4 + 8 \times 3 = 4 + 24 = 28$.

Tripwire Check

These questions test whether the thinking is solid — not just whether the procedure was memorized. Each wrong answer below points to a specific misconception, not just "try again."

1. Evaluate both -4^2 and $(-4)^2$. Explain why the answers are different.

Correct answer: $-4^2 = -16$ and $(-4)^2 = 16$.

Likely wrong answer: Both equal 16.

Misconception: Ignores brackets and treats the negative sign as part of the base in both expressions.

Next move: Return to Worked Examples 5 and 6. Identify the base before expanding.

2. A student writes $2^4 \times 5^3 = 10^7$. Explain why this is incorrect. Then evaluate the original expression.

Correct answer: Bases differ. $2^4 = 16$ and $5^3 = 125$, so the product is 2,000.

Likely wrong answer: 10^7

Misconception: Adds exponents and multiplies bases when the bases differ.

Next move: Return to the HABIT box. Expand or evaluate when bases differ.

Answer Key — Worksheets (Full Diagnostic)

Worksheet A: Guided Practice

1. Identify the base and exponent in 13^2 .

1. Base 13; exponent 2. Likely wrong answer: Base 2, exponent 13 (swaps the base and exponent). Misconception: The positions of the base and exponent are reversed when naming them.

2. Write 8^3 in expanded form.

2. $8 \times 8 \times 8$. Likely wrong answer: 8×3 (multiplies the base by the exponent instead of repeating it as a factor). Misconception: The exponent is read as a multiplier on the base rather than as a count of repeated factors.

3. Evaluate: 11^2

3. 121. Likely wrong answer: 22 (multiplies the base by the exponent instead of by itself). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

4. Evaluate: 9^4

4. 6,561. Likely wrong answer: 36 (multiplies the base by the exponent instead of repeated multiplication). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

5. Evaluate: 11^0

5. 1. Likely wrong answer: 0 (assumes any exponent of zero makes the whole expression zero). Misconception: A zero exponent is confused with a zero base or a zero result.

6. Evaluate: -8^2

6. -64. Likely wrong answer: 64 (brackets the negative sign into the base without brackets given). Misconception: The negative sign is treated as part of the base even though no bracket encloses it.

7. Evaluate: $(-7)^2$

7. 49. Likely wrong answer: -49 (drops the bracket's effect, applying the negative outside the square). Misconception: The bracket enclosing the negative base is ignored, so the negative sign is applied after squaring instead of before.

8. Simplify: $7^2 \times 7^5$

8. $7^7 = 823,543$. Likely wrong answer: 49^{10} or a value from multiplying the exponents instead of adding them. Misconception: Exponents with the same base being multiplied are combined by multiplying instead of adding.

9. Simplify: $8^6 \div 8^2$

9. $8^4 = 4,096$. Likely wrong answer: 8^3 or a value from adding the exponents instead of subtracting them. Misconception: Exponents with the same base being divided are combined by adding instead of subtracting.

10. Simplify: $(6^2)^3$

10. $6^6 = 46,656$. Likely wrong answer: 6^5 or a value from adding the exponents instead of multiplying them. Misconception: A power raised to another power is combined by adding the exponents instead of multiplying them.

11. Evaluate: $2^5 + 3$

11. 35. Likely wrong answer: 2^8 (adds the 3 to the exponent before evaluating). Misconception: The addition is performed before the exponent is evaluated instead of after.

12. Evaluate: 3×7^2

12. 147. Likely wrong answer: 21^2 (multiplies 3 and 7 before applying the exponent). Misconception: The multiplication is performed before the exponent is evaluated instead of after.

13. Explain why $3^4 \times 5^2$ cannot be written as one power.

13. Bases differ; $3^4 \times 5^2 = 81 \times 25 = 2,025$. Likely wrong answer: tries to combine into one power despite the different bases. Misconception: Powers with different bases are treated as combinable the same way powers with matching bases are.

14. Write a power with base 10 and exponent 5. Then state its value.

14. $10^5 = 100,000$. Likely wrong answer: gives a power with a base other than 10, or miscounts the zeros in the value. Misconception: The connection between the exponent and the number of zeros in a power of 10 is applied incorrectly.

15. Explain why 9^2 does not mean 9×2 .

15. $9^2 = 9 \times 9 = 81$, not $9 \times 2 = 18$. Likely wrong answer: explains only that the answer is 81, without naming the repeated-multiplication rule. Misconception: The explanation gives the correct value but doesn't identify why multiplying the base by the exponent is the wrong method.

Worksheet B: Independent Practice

1. Identify the base and exponent in 14^3 .

1. Base 14; exponent 3. Likely wrong answer: Base 3, exponent 14 (swaps the base and exponent). Misconception: The positions of the base and exponent are reversed when naming them.

2. Write 12^2 in expanded form.

2. 12×12 . Likely wrong answer: 12×2 (multiplies the base by the exponent instead of repeating it as a factor). Misconception: The exponent is read as a multiplier on the base rather than as a count of repeated factors.

3. Evaluate: 6^4

3. 1,296. Likely wrong answer: 24 (multiplies the base by the exponent instead of repeated multiplication). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

4. Evaluate: 13^3

4. 2,197. Likely wrong answer: 39 (multiplies the base by the exponent instead of repeated multiplication). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

5. Evaluate: 4^5

5. 1,024. Likely wrong answer: 20 (multiplies the base by the exponent instead of repeated multiplication). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

6. Evaluate: 15^0

6. 1. Likely wrong answer: 0 (assumes any exponent of zero makes the whole expression zero). Misconception: A zero exponent is confused with a zero base or a zero result.

7. Evaluate: -9^3

7. -729. Likely wrong answer: 729 (brackets the negative sign into the base without brackets given). Misconception: The negative sign is treated as part of the base even though no bracket encloses it.

8. Evaluate: $(-11)^3$

8. -1,331. Likely wrong answer: 1,331 (drops the bracket's effect, losing the negative sign in an odd power). Misconception: The bracket enclosing the negative base is ignored, changing the sign of the final result.

9. Simplify: $11^3 \times 11^2$

9. $11^5 = 161,051$. Likely wrong answer: 11^6 or a value from multiplying the exponents instead of adding them. Misconception: Exponents with the same base being multiplied are combined by multiplying instead of adding.

10. Simplify: $10^7 \div 10^4$

10. $10^3 = 1,000$. Likely wrong answer: 10^{11} or a value from adding the exponents instead of subtracting them. Misconception: Exponents with the same base being divided are combined by adding instead of subtracting.

11. Evaluate: $9 + 4^2 \times 3$

11. 57. Likely wrong answer: 51 (multiplies before evaluating the exponent, or adds before multiplying). Misconception: The order of the exponent and the surrounding operations is not followed correctly.

12. Simplify: $(3^3)^4$

12. $3^{12} = 531,441$. Likely wrong answer: 3^7 or a value from adding the exponents instead of multiplying them. Misconception: A power raised to another power is combined by adding the exponents instead of multiplying them.

13. Simplify: $(5^3)^2$

13. $5^6 = 15,625$. Likely wrong answer: 5^5 or a value from adding the exponents instead of multiplying them. Misconception: A power raised to another power is combined by adding the exponents instead of multiplying them.

14. Evaluate: $25 - 3^2 + 4$

14. 20. Likely wrong answer: 12 (subtracts and adds out of left-to-right order, or evaluates the exponent last). Misconception: The exponent is not evaluated before the surrounding addition and subtraction.

15. Explain why $4^3 \times 6^2$ cannot be written as 24^5 .

15. Bases differ; $4^3 \times 6^2 = 64 \times 36 = 2,304$, not 24^5 . Likely wrong answer: tries to combine into 24^5 despite the different bases. Misconception: Powers with different bases are treated as combinable the same way powers with matching bases are.

16. Simplify: $12^5 \div 12^3$

16. $12^2 = 144$. Likely wrong answer: 12^2 miscounted, or a value from adding the exponents instead of subtracting them. Misconception: Exponents with the same base being divided are combined by adding instead of subtracting.

17. Evaluate: $(-5)^3$

17. -125. Likely wrong answer: 125 (drops the bracket's effect, losing the negative sign in an odd power). Misconception: The bracket enclosing the negative base is ignored, changing the sign of the final result.

18. Evaluate: -11^2

18. -121. Likely wrong answer: 121 (brackets the negative sign into the base without brackets given). Misconception: The negative sign is treated as part of the base even though no bracket encloses it.

19. Evaluate: $2^6 + 5^2$

19. 89. Likely wrong answer: 77 (multiplies the base by the exponent for one or both terms). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

20. Explain why $6^2 + 6^3$ cannot be simplified as 6^5 .

20. $36 + 216 = 252$, not $6^5 = 7,776$. Likely wrong answer: tries to combine into 6^5 by adding the exponents despite the addition between terms. Misconception: Exponents are added across a sum of two powers, a rule that only applies to multiplication of matching bases.

Worksheet C: Mixed Application

1. A student says $10^3 = 10 \times 3 = 30$. Explain the mistake and find the correct value.

1. $10^3 = 10 \times 10 \times 10 = 1,000$. Likely wrong answer: 30. Misconception: The exponent is treated as a multiplier. Next move: Expand the power as repeated multiplication.

2. A cube has an edge length of 7 cm. Write an expression for its volume and calculate the volume.

2. $7^3 = 343 \text{ cm}^3$. Likely wrong answer: $7 \times 3 = 21 \text{ cm}^3$ (multiplies the base by the exponent instead of cubing it). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

3. Evaluate: $8^2 - 3^3$

3. 37. Likely wrong answer: subtracts before evaluating both exponents. Misconception: One or both exponents are not evaluated before the subtraction is performed.

4. Evaluate: $1 + 5^2 \times 4$

4. 101. Likely wrong answer: multiplies before evaluating the exponent, or adds before multiplying. Misconception: The order of the exponent and the surrounding operations is not followed correctly.

5. Simplify: $9^6 \div 9^4$

5. $9^2 = 81$. Likely wrong answer: 9^{10} or a value from adding the exponents instead of subtracting them. Misconception: Exponents with the same base being divided are combined by adding instead of subtracting.

6. Simplify: $(7^2)^2$

6. $7^4 = 2,401$. Likely wrong answer: 7^4 miscalculated, or a value from adding the exponents instead of multiplying them. Misconception: A power raised to another power is combined by adding the exponents instead of multiplying them.

7. A student says $-10^2 = 100$. Explain the error and find the correct value.

7. -100. No brackets: the base is 10 only, and the negative sign stays outside.

8. Evaluate: $(-3)^5 + 8$

8. -235. Likely wrong answer: 235 or a positive value (drops the bracket's effect, losing the negative sign in an odd power). Misconception: The bracket enclosing the negative base is ignored, changing the sign of the final result.

9. A square garden has side length 13 m. Write an expression for its area and calculate the area.

9. $13^2 = 169 \text{ m}^2$. Likely wrong answer: $13 \times 2 = 26 \text{ m}^2$ (multiplies the base by the exponent instead of squaring it). Misconception: The exponent is read as a multiplier on the base rather than as repeated multiplication.

10. Simplify: $8^4 \times 8^3$

10. $8^7 = 2,097,152$. Likely wrong answer: 8^{12} or a value from multiplying the exponents instead of adding them. Misconception: Exponents with the same base being multiplied are combined by multiplying instead of adding.

11. Evaluate: $3^5 - 2^4$

11. 227. Likely wrong answer: subtracts before evaluating both exponents. Misconception: One or both exponents are not evaluated before the subtraction is performed.

12. A student says $3^2 \times 4^3 = 12^5$. Explain why this is incorrect. Then evaluate the original expression.

12. Bases differ; $3^2 \times 4^3 = 9 \times 64 = 576$. Likely wrong answer: agrees $3^2 \times 4^3 = 12^5$ without checking the bases. Misconception: Powers with different bases are treated as combinable the same way powers with matching bases are.

13. Evaluate: $6 + 5^3 \div 25$

13. 11. Likely wrong answer: divides before evaluating the exponent, or adds before dividing. Misconception: The order of the exponent and the surrounding operations is not followed correctly.

14. Non-Routine: Create two powers with the same base that has not appeared earlier in this chapter. One must be greater than 100 and the other less than 100. Explain why.

14. Answers vary. Example with base 6: $6^2 = 36$ is less than 100 and $6^3 = 216$ is greater than 100. Likely wrong answer: uses two different bases. Misconception: The same-base condition is overlooked. Next move: Fix one base first, then test consecutive exponents.

15. Non-Routine: A student writes $(-9)^2 = -(9^2) = -81$. Identify the first incorrect step. Then evaluate correctly.

15. The first incorrect step is $(-9)^2 = -(9^2)$. The brackets make -9 the base, so $(-9)^2 = (-9)(-9) = 81$. Likely wrong answer: -81 . Misconception: Brackets around a negative base are ignored. Next move: Underline the complete base before expanding the power.

Answer Key — Exit Ticket

1. 256.
2. $5^7 = 78,125$.
3. 81.