Power Up With Exponents

Teacher		**Class**	Grade 6
Subject	Math	**Topic**	Whole-number exponents
Date		**Room**	
Lesson length	60 minutes	**Country**	United States

Students learn to write repeated multiplication as powers and find the value. They build squares and cubes, then use order of operations with powers.

Curriculum links

- generate equivalent numerical expressions using order of operations, including whole number exponents [1]
- Use the order of operations and properties of real numbers to simplify numerical expressions with exponents 1, 2, 3, or 4 and positive integer bases [2]

Learning objectives

- Students will write repeated multiplication as powers using base and exponent.
- Students will evaluate whole-number powers with small exponents by multiplying in steps.
- Students will evaluate numerical expressions with powers using order of operations.

Success criteria

- I can name the base and exponent in a power.
- I can write the expanded form and find its value.
- I can do powers first in order of operations.

What students already know

Ask students to solve 3 x 3, 2 x 2 x 2, and 10 x 10 x 10 quickly on whiteboards to check fluent multiplication.

Key words

base	the big number that gets multiplied again and again [5]
exponent	the little number that shows how many copies to multiply [5]
power	the whole short form like 3 to the 4th
expanded form	the long multiplication written out with x signs [5]
order of operations	the rules that say to do powers before x and + [1]

Materials

- square tiles
- linking cubes
- small whiteboards and markers
- printed copies of Worksheet Task B
- printed copies of Worksheet Task D
- slides 1-7 and 10-12 with projector
- Video clip 1 ready to play 0:00-5:00

Before the lesson

- Print Worksheet Task B and Task D, one copy per student
- Test Slides 1-7 and 10-12 and Video clip 1 (0:00-5:00) on slide 6
- Set out square tiles, linking cubes, and whiteboards for groups

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Lesson outline

0–8 min **Starter** 8 min · Whole class

Connect fluent multiplication to squares, cubes, and powers of 10.

YOU DO

1. Show Slide 1 title and Slide 2 objectives and read them aloud.
2. Show Slide 3 cards for squares, cubes, and powers of 10 with area and volume pictures.
3. Use the hook: Can you build 3 squared so I can actually see it?
4. Ask for quick multiplication facts and link 5 x 5 to 5 squared.

STUDENTS DO

1. Read objectives with the teacher.
2. Answer multiplication facts on whiteboards.
3. Predict what 3 squared would look like as rows.

Say: Can you build 3 squared so I can actually see it? Today we will write powers using base and exponent and evaluate them. A square like 5 squared shows area, and a cube like 2 cubed shows volume.

Worked example: 5 squared = 5 x 5 = 25. Count 2 factors of 5, then multiply: 5 x 5 = 25.

Ask: What is 3 x 3, and how could you show it as rows? (9, as 3 rows of 3.) · What is 2 x 2 x 2, and why might it make a cube? (8; it makes 2 layers by 2 rows by 2.) · What is 10 x 10 x 10? (1,000.)

Check understanding: Scan whiteboards for 9, 8, and 1,000. Reteach any fact with a quick array sketch if many miss it.

Support: Show rows of dots for 3 x 3 while students say the fact aloud. **Stretch:** Ask what 10 to the 4th would mean in expanded form and its value.

Use: Slides 1–3

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8–20 min **Teaching** 12 min · Whole class

Model how to name parts of a power and evaluate it step by step.

YOU DO

1. Teach Slide 4 steps: spot base and exponent, write expanded multiplication, multiply left to right.
2. Use Slide 5 mystery to confirm 2 x 2 x 2 x 2 is 2 to the 4th and equals 16.
3. Play Video clip 1 on Slide 6 and have students listen for base, exponent, and expanded form.
4. State the Slide 7 big idea and model 3 to the 4th fully.

STUDENTS DO

1. Say base, exponent, and expanded form aloud with the teacher.
2. Watch the video and say the value aloud when asked.
3. Copy the 3 to the 4th steps onto whiteboards.

Say: The large number is called the base and the small number is called the exponent [5]. An exponent tells how many times to multiply the base by itself [5]. We keep to positive integer bases with exponents 1, 2, 3, or 4 [2].

Worked example: 3 to the 4th = 3 x 3 x 3 x 3. Multiply left to right: 3 x 3 = 9, 9 x 3 = 27, 27 x 3 = 81, so 3 to the 4th = 81.

Ask: In 3 to the 4th, what is the base and what is the exponent? (Base is 3, exponent is 4.) · What is the expanded form and why do we multiply left to right? (3 x 3 x 3 x 3; to keep order and avoid skip errors, 9, then 27, then 81.)

Check understanding: All show expanded form and 81 on whiteboards. Remodel writing the four 3s if expanded forms are short.

Support: Circle the big base and small exponent in color and count the factors together. **Stretch:** Ask students to predict which is greater, 3 to the 4th or 4 cubed, before calculating.

Use: Slides 4–7, Video clip 1 (0:00–5:00)

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20–40 min **Main activity** 20 min · Groups

Build squares and cubes to write and evaluate powers.

YOU DO

1. Demo building 2 to the second power as 2 rows of 2 with tiles.
2. Demo building 2 to the third power as a 2 by 2 by 2 cube with linking cubes.
3. Have groups build, sketch the model, and write the full chain like 3 to the third power = 3 x 3 x 3 = 27.
4. Give Worksheet Task B for fluency practice with powers of whole numbers [3] and circulate.

STUDENTS DO

1. Build 2 squared, 3 squared, 2 cubed, and 3 cubed with tiles and cubes.
2. Sketch each model and write exponent form, expanded form, and value.
3. Complete Worksheet Task B to build fluency with powers.

Say: Build it, sketch it, then write it. Show the exponent form, the expanded multiplication, and the value. For 3 to the third power, write 3 x 3 x 3 and multiply in steps to get 27.

Worked example: 2 cubed = 2 x 2 x 2. Build 2 by 2 by 2, then 2 x 2 = 4 and 4 x 2 = 8, so 2 cubed = 8.

Ask: How does your build show the exponent? (It shows how many 2s or 3s are multiplied, like 3 rows of 3 for exponent 2.) · How did you get the value of 3 cubed step by step? (3 x 3 x 3, 3 x 3 = 9, 9 x 3 = 27.)

Check understanding: Check sketches and chains for correct factor count and product. Have a group read one chain aloud if errors appear.

Support: Give the expanded form first and have students count and multiply in steps, like 2 x 2 = 4, then 4 x 2.
Stretch: Build and compare 2 to the fourth power and 4 squared to see different expressions can have the same value.

Use: Worksheet Task B

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40–50 min **Practice** 10 min · Pairs

Evaluate expressions with powers using order of operations.

YOU DO

1. Model 2 + 3 squared, showing the power value first, then addition.
2. Remind students to generate equivalent numerical expressions using order of operations, including whole number exponents [1].
3. Have pairs solve Worksheet Task D using order of operations and exponents.
4. Have pairs show two lines of work for each expression.

STUDENTS DO

1. Solve Worksheet Task D in pairs, writing power first then final step.
2. Compare answers with another pair and explain any mismatch.

Say: Do powers first in order of operations. For 2 + 3 squared, first find 3 squared = 9, then add. So 2 + 9 = 11, not 25.

Worked example: 2 x 5 squared = 2 x 25 = 50. First 5 squared = 5 x 5 = 25, then 2 x 25 = 50.

Ask: Why is 2 + 3 squared not 5 squared? (Powers come before addition, so 3 squared = 9 first, then 2 + 9 = 11.) · What are the two steps for 4 squared - 10? (4 squared = 16 first, then 16 - 10 = 6.)

Check understanding: Scan two-line work for power-first step. Re-model one example on the board if pairs add first.

Support: Post the order steps and give only one operation with the power, like 10 + 2 cubed. **Stretch:** Use expressions with two powers, like 2 squared + 3 squared, and ask for another expression with the same value.

Use: Worksheet Task D

50–60 min **Plenary** 10 min · Whole class

Check that students can write, evaluate, and order powers.

YOU DO

1. Review Slide 10 key words: base, exponent, power, and expanded form.
2. Run Slide 11 think, pair, share: Is 3 squared the same as 2 cubed?
3. Run Slide 12 quick quiz on whiteboards and confirm answers.
4. Link back to success criteria and set homework.

STUDENTS DO

1. Define base and exponent to a partner.
2. Discuss 3 squared versus 2 cubed and share reasoning.
3. Answer the four quiz questions on whiteboards.

Say: Turn and tell your partner if 3 squared equals 2 cubed and how you know. Then show each quiz answer on your board. Remember the exponent shows how many times to multiply the base by itself [5].

Ask: Is 3 squared the same as 2 cubed? How do you know? (No; 3 squared = 9, 2 cubed = 8.) · Why does 3 + 2 cubed equal 11? (2 cubed = 8 first, then 3 + 8 = 11.)

Check understanding: Use whiteboard quiz: 4 cubed, 25, 16, 11. Reteach expanded form for any question below 80% correct.

Support: Allow a reference card with 2 squared through 5 squared during discussion. **Stretch:** Ask students to write another expression equal to 11 using a different power.

Use: Slides 10–12

Common mistakes

Mistake	How to spot it	How to fix it
Writing 3 squared as 3 x 2 instead of 3 x 3	Expanded form has 2 as a factor instead of two 3s	Restate that the exponent shows how many times to multiply the base by itself [5] and rewrite as 3 x 3 = 9.
Writing 2 cubed as 2 x 3 = 6	Student multiplies base by exponent	Count three 2s in expanded form 2 x 2 x 2, then multiply 4 x 2 = 8 [5].
Doing addition first, like 2 + 3 squared = 25	Final answer is the square of the sum	Remodel order of operations with whole number exponents [1]: find 3 squared = 9 first, then 2 + 9 = 11.

Support

- Provide expanded form first and use tiles so students count factors before multiplying.
- Allow a multiplication chart but require the expanded form line before the product.

Stretch

- Compare 2 to the fourth power and 4 squared to find equal values different ways.
- Create expressions with two powers that equal a target number.

For the LSE or teaching assistant

Sit with target groups during building and Task D. Prompt factor counting, check expanded form length, and ask students to read chains aloud.

Check for understanding

Question	Answer
Write 4 x 4 x 4 as a power.	4 cubed
Evaluate 5 squared.	25
Evaluate 3 + 2 cubed. Show the power first.	11, because 2 cubed = 8 first

Homework

Complete Worksheet Task C: find the first wrong step and correct it.

Sources

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