Fix It: Operations in Scientific Notation

Teacher		**Class**	Grade 8
Subject	Math	**Topic**	Scientific notation
Date		**Room**	
Lesson length	60 minutes	**Country**	United States

Students learn to multiply, divide, add and subtract in scientific notation. They find errors in mixed decimal and scientific solutions and fix them.

Curriculum links

- Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used.

Learning objectives

- Students will multiply and divide in scientific notation and renormalize answers.
- Students will add and subtract by matching exponents after converting decimals.
- Students will spot and fix errors in mixed-notation operation solutions.

Success criteria

- I can multiply and divide and fix the answer to proper form.
- I can convert a decimal then add or subtract with the same power.
- I can explain what rule was broken and fix it.

What students already know

2-minute check: show 32000000 and 0.000467 [3]. Students write both in scientific notation on whiteboards.

Key words

scientific notation	short way to write very big or very tiny numbers using 10 raised to a power [8]
coefficient	front number that is 1 or more but less than 10 [8]
exponent	tiny raised number showing how many places the point moves [4]
normalized form	fixed writing with the front number kept from 1 up to less than 10 [12]

Materials

- Slides 1-12
- error-analysis handout (1 per pair, 3 wrong solutions printed)
- highlighters
- Worksheet Task B (Practice operations with scientific notation. Write answers in scientific notation.)
- Worksheet Task C (Add and subtract with same exponents. Change decimals when you need to.)
- mini whiteboards and markers
- timer

Before the lesson

- Load Slides 1-12 and test Video clip 2 (0:00-4:56) on slide 8 with sound
- Print error-analysis handout 1 per pair - Problem 1: 3 x 10^4 + 5 x 10^5 = 8 x 10^9 shown as correct; Problem 2: 0.004 x (2.5 x 10^6) = 0.01 x 10^6 left un-normalized shown as finished; Problem 3: (6.1 x 10^5) / (1.2 x 10^-3) = 5.08 x 10^2 shown as correct
- Print Worksheet Task C (Add and subtract with same exponents. Change decimals when you need to.) for guided practice and Worksheet Task B (Practice operations with scientific notation. Write answers in

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scientific notation.) for main activity finishers and homework
- Put out highlighters, whiteboards, markers

Lesson outline

0–7 min **Starter** 7 min · Whole class

Hook students and recall conversion between decimal and scientific notation.

YOU DO

1. Show Slide 1: Huge or Tiny? Let's Compute It! and read title: Operations with scientific notation, decimals included.
2. Show Slide 2 photo and read: Light travels 300,000,000 meters in one second. Imagine multiplying with all those zeros! Ask why zeros make it hard.
3. Say the hook and set goal for finding errors in mixed work.
4. Quick-check conversions: show 32000000 and 0.000467 and have all convert [3].

STUDENTS DO

1. Discuss with neighbor why 300,000,000 meters per second is hard to multiply [4].
2. Write both conversions on whiteboards and hold up.
3. Compare answers and state the exponent sign rule.

Say: Someone already did the homework. Too bad half of it is wrong. Can you catch it? Today we will operate with huge and tiny numbers and fix mistakes when decimals and scientific notation are mixed.

Worked example: 32000000 = 3.2 x 10^7. Move point 7 places left, exponent +7. 0.000467 = 4.67 x 10^-4. Move point 4 places right, exponent -4 [3][5]. Scientific notation is m x 10^n where m is greater than or equal to 1 but less than 10 [8].

Ask: Why write 300,000,000 as 3 x 10^8? (Fewer zeros, easier to see size and to multiply; coefficient between 1 and 10 times power of 10 [8].) · How do you know the exponent for 0.000467 is -4? (Number is less than 1, moved point 4 right, so negative exponent [4][5].)

Check understanding: Scan whiteboards for 3.2 x 10^7 and 4.67 x 10^-4. If many miss sign, redo one with point-move arrows before moving on.

Support: Show place-value chart with arrows for moving the point left for big and right for small. **Stretch:** Ask what 10^0 means and what number has exponent 0.

Use: Slides 1-2

7–20 min **Teaching: multiply and divide** 13 min · Whole class

Model multiplying and dividing by handling coefficients and powers separately.

YOU DO

1. Show Slide 3 cards and read: Coefficient - A number from 1 to less than 10. Base 10 - Always 10, shifts the decimal point. Exponent - Positive for big, negative for tiny.
2. Show Slide 4 steps and read: Split it: coefficients together, powers of 10 together. Multiply coefficients and add exponents; divide and subtract.
3. Model (4.5 x 10^-14) x (5.2 x 10^3) step by step on board [3].
4. Model (6.1 x 10^5) / (1.2 x 10^-3) and stress 5 - (-3) = 8 [3].

STUDENTS DO

1. Copy the two steps labeled coefficient math and exponent math.
2. Call out products, quotients and exponent sums with partner.
3. Circle final normalized answers.

Say: Split it every time. Coefficients do their own math, exponents do theirs. Multiply means add exponents, divide means subtract them. Then fix it so the front number is 1 to less than 10.

Worked example: (4.5 x 10^-14) x (5.2 x 10^3) = (4.5 x 5.2) x 10^(-14+3) = 23.4 x 10^-11. Fix: 23.4 = 2.34 x 10^1, so 2.34 x 10^-10. Handle coefficients and exponents separately [20] and renormalize so absolute value stays at least 1 but less than 10 [12]. Division: (6.1 x 10^5)/(1.2 x 10^-3) is about 5.08 x 10^8 because 6.1/1.2 is about 5.08 and 5-(-3)=8 [3].

Ask: Why do we add exponents when we multiply? (Powers of 10 multiply by counting total tens; 10^a x 10^b = 10^(a+b).) · Why is 23.4 x 10^-11 not finished? (Coefficient must be 1 to less than 10, so shift to 2.34 x 10^-10 [8][12].) · In division why is 5 - (-3) = 8? (Subtracting a negative adds; exponent grows because we divide by a tiny number.)

Check understanding: Hinge with whiteboards: (2 x 10^4) x (3 x 10^-2) = ?. Look for 6 x 10^2. Reteach split if exponents added wrong.

Support: Give frame with blanks: __ x __ for coefficients and -14 + 3 for exponents, plus a multiplication chart.
Stretch: Convert then multiply: 0.004 x (2.5 x 10^6). First change 0.004 to 4 x 10^-3, then get 1.0 x 10^4.

Use: Slides 3-4

20–32 min **Teaching: add and subtract mixed** 12 min · Whole class

Show that addition and subtraction need the same exponent after converting decimals.

YOU DO

1. Show Slide 7 compare: Add and Subtract - First match the exponents exactly. Add coefficients, keep the power.
2. Play Video clip 2 (0:00-4:56) on Slide 8. Tell students to spot turning 0.000467 into scientific notation and how mixed answers return to proper form.
3. Model 3,500 + 2.1 x 10^4 by rewriting 3,500 as 0.35 x 10^4, then adding to get 2.45 x 10^4.
4. Start Worksheet Task C (Add and subtract with same exponents. Change decimals when you need to.) together for one same-exponent problem.

STUDENTS DO

1. Watch video and note when to add or subtract exponents versus when to match them.
2. Copy the 3,500 rewrite and add coefficients with teacher.
3. Do first Task C (Add and subtract with same exponents. Change decimals when you need to.) question in pairs and read answer aloud.

Say: You cannot just add exponents when you add. Match them first. Turn any decimal into scientific notation, rewrite one number so powers match, then add the front numbers and keep the power.

Worked example: 3,500 + 2.1 x 10^4: 3,500 = 0.35 x 10^4. Then 0.35 x 10^4 + 2.1 x 10^4 = 2.45 x 10^4. Addition requires making the exponents the same before performing the operation [20].

Ask: Why is 3 x 10^4 + 5 x 10^5 = 8 x 10^9 wrong? (Exponents were added; must match exponents then add 0.3 + 5 to get 5.3 x 10^5.) · What do you do first with 0.000467 + 5.43 x 10^-3? (Convert 0.000467 to 4.67 x 10^-4 or 0.467 x 10^-3, then match to 10^-3 [3].)

Check understanding: Thumbs up/down: can you add with different exponents? Cold-call rule in own words. If unsure, show expanded 21,000 + 3,500 alongside forms.

Support: Provide place-value expanded forms like 21,000 + 3,500 alongside scientific forms so students see why exponents must match. **Stretch:** Ask what goes wrong if final answer is left as 24.5 x 10^3 instead of normalized form.

Use: Slides 7-8, Video clip 2 (0:00–4:56), Worksheet Task C (Add and subtract with same exponents. Change decimals when you need to.)

32–52 min **Main activity: find and fix** 20 min · Pairs

Let pairs find errors in mixed solutions and solve mixed problems correctly.

YOU DO

1. Hand out error-analysis handout and highlighters. Student A and Student B get worked solutions where a decimal was not converted or exponents were added during addition.
2. Model Problem 1 together: highlight where exponents were added, rewrite correctly using same-exponent rule.
3. Direct pairs to highlight each error, rewrite correctly, and write what rule was broken in the margin.
4. Show Slide 9 Your task: A) 0.000467 + 5.43 x 10^-3 = ? B) (4.5 x 10^3) x 2,000 = ? C) 32,000,000 / (4 x 10^6) = ? Fix proper form. Compare: which result is biggest? How do you know?

STUDENTS DO

1. Highlight errors: Problem 1 added exponents, Problem 2 left 0.01 x 10^6 un-normalized, Problem 3 dropped the minus sign (5 - 3 instead of 5 - (-3) = 8).
2. Rewrite correctly: 1) 5.3 x 10^5; 2) 1.0 x 10^4; 3) about 5.08 x 10^8, and note rule broken.
3. Solve Slide 9 A-C, fix proper form, and compare sizes by exponent first.

Say: You are the detectives. Highlight exactly where it breaks, fix it, and write the rule. Convert decimals first, match powers to add, split parts to multiply and divide. Then prove it on the three task problems.

Ask: What rule was broken in Problem 1? (Added exponents during addition; must make exponents the same before performing the operation [20].) · How do you compare A, B, C for biggest? (Look at exponent first after normalizing; B is 9 x 10^6 so biggest.)

Check understanding: Collect one fixed solution per pair on whiteboard. Check checklist: converted, same exponent for add, coefficient 1 to <10 [12]. Pull small group if converting missed.

Support: Provide a checklist: 1. Converted? 2. Same exponent for add/subtract? 3. Coefficient between 1 and 10? **Stretch:** Have partners create one new error problem for another pair to fix, including a negative exponent.

Use: Slide 9

52–60 min **Plenary** 8 min · Whole class

Confirm the big idea and check who can operate with mixed forms.

YOU DO

1. Show Slide 10 and read: Coefficients do the arithmetic, exponents track the size.
2. Show Slide 11 vote: Sun is about 150,000,000 km away. Which display helps you grasp size fastest? 150,000,000 km, 1.5 x 10^8 km, 1.5E8 calculator form. Take vote and link exponent to size [20].
3. Show Slide 12 exit ticket and have students write answers.

STUDENTS DO

1. Vote and justify which sun distance display shows size fastest.
2. Complete exit ticket sentences and one calculation.
3. Share one rule with partner.

Say: Say it back to me: coefficients do the math, exponents track the size. Scientific form shows size fastest because the exponent tells magnitude. Now show me one mixed problem you can do.

Worked example: B) (4.5 x 10^3) x 2,000: 2,000 = 2 x 10^3, so 9 x 10^6. C) 32,000,000/(4 x 10^6): 3.2 x 10^7 / 4 x 10^6 = 0.8 x 10^1 = 8. A) 0.000467 + 5.43 x 10^-3 = 5.897 x 10^-3.

Ask: When do you add exponents and when do you not? (Add for multiply, subtract for divide; never add to add or subtract, match powers instead [20].) · Why does 1.5 x 10^8 km beat 150,000,000 km? (Exponent 8 shows order of magnitude at a glance; distance to the sun is 1.5 x 10^8 km [20].)

Check understanding: Read exit tickets as they leave. If matching exponents still weak, start next lesson with Task C (Add and subtract with same exponents. Change decimals when you need to.) review.

Support: Give sentence starters: One operation I can now do is __ because __. **Stretch:** Ask how time 5 x 10^2 seconds changes if distance doubled to 3.0 x 10^11 meters.

Use: Slides 10-12

Common mistakes

Mistake	How to spot it	How to fix it
Adding or subtracting exponents when adding or subtracting, like 3 x 10^4 + 5 x 10^5 = 8 x 10^9	Answer power is sum of powers and coefficients just added	Rewrite to same power first, add coefficients only, keep power; 0.3 x 10^5 + 5 x 10^5 = 5.3 x 10^5 [20]
Leaving answer not normalized, like 23.4 x 10^-11 or 0.01 x 10^6	Front number is 10 or more or less than 1	Shift point so absolute value is at least 1 but less than 10, adjust exponent, to 2.34 x 10^-10 [12]
Operating on a decimal without converting, like adding 0.000467 directly	Work mixes 0.000467 with 10^-3 with no conversion step	First write 0.000467 as 4.67 x 10^-4 [3], match powers, then operate

Support

- Provide a checklist: 1. Converted? 2. Same exponent for add/subtract? 3. Coefficient between 1 and 10?
- Allow calculator for coefficient division only and focus on writing exponent step correctly

Stretch

- Have partners create one new error problem for another pair to fix, including a negative exponent.
- Require multiplying the addition result by 2 x 10^3 and renormalizing it

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For the LSE or teaching assistant

Stay with target pairs during main activity. Prompt checklist use, point to highlight exact error line, scribe rewrite if needed, push early finishers to Slide 9 comparison.

Check for understanding

Question	Answer
(4.5 x 10^-14) x (5.2 x 10^3) = ?	2.34 x 10^-10
0.000467 + 5.43 x 10^-3 = ?	5.897 x 10^-3
32,000,000 / (4 x 10^6) = ?	8

Homework

Finish Worksheet Task B (Practice operations with scientific notation. Write answers in scientific notation.).

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