

GRADE 8 · EXPRESSIONS & EQUATIONS · ANSWER KEY

SCIENTIFIC NOTATION

Today's goal: I can use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other and perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used.



How to use this key. Problem numbers match the student sheets. Each answer shows the steps and the slip Mr DJ sees most, so a wrong answer tells you what to reteach. Pepper levels: **Mild** warm-up, **Medium** stretch, **Spicy** challenge, **Extra Spicy** big brain.

Practice

9 problems + Mr DJ's worked example

Use: In-class practice after the deck. Items 8 and 6 are a deliberate pair: same power, then different powers. A child who learned 'just add the fronts' from item 8 gets item 6 wrong, which is why item 8's rule is stated as 'same power'. **Timing:** 15–20 min · pairs · items 7 and 6 on the board.

- 1** 4.2×10^3 and 5.6×10^{-4}
2 3 000 000
3 1.5×10^8
4 3×10^5
5 2×10^5 , or 200 000 times wider
6 8.3×10^5
7 no — 3.4×10^5
8 7×10^6 , because 10^6 is a shared unit
9 4×10^{-3} is bigger

1 **MILD** 4 200 and 0.00056

4.2×10^3 and 5.6×10^{-4}

- 4 200: point moves three places left.
- 0.00056: point moves four places right, so a negative power.

Watch for: Counted the zeros rather than the places moved — 0.00056 has four zeros but the power is -4 for a different reason, and the two agree here by coincidence rather than by rule.

2 **MILD** A positive power

3 000 000

- 10^6 means multiply by ten six times.
- 3 followed by six zeros: 3 000 000.

Watch for: Miscounted the zeros. The exponent IS the number of zeros when the front number is a single digit.

3 **MEDIUM** $(3 \times 10^4)(5 \times 10^3)$

1.5×10^8

- $3 \times 5 = 15$ and $4 + 3 = 7$, giving 15×10^7 .
- 15 is out of range, so renormalise: 1.5×10^8 .
- This is the step most often dropped.

Watch for: Left 15×10^7 , which is correct in value and not in form. The renormalising step is what this item is for.

4 **MEDIUM** $(6 \times 10^8) \div (2 \times 10^3)$

3×10^5

- $6 \div 2 = 3$ and $8 - 3 = 5$.

Watch for: Divided the powers, or subtracted the coefficients.

5 **MEDIUM** Cell against atom

2×10^5 , or 200 000 times wider

1. Divide: $2 \div 1 = 2$.
2. Powers: $-5 - (-10) = -5 + 10 = 5$.
3. So $2 \times 10^5 = 200\,000$ times.

Watch for: Subtracted the powers as $-5 - 10 = -15$. Subtracting a negative is the trap, and it is arithmetic rather than notation — worth separating when marking.

6 **MEDIUM** $8 \times 10^5 + 3 \times 10^4$

8.3×10^5

1. The powers differ, so they cannot simply be added as counts.
2. Rewrite to a common power: $3 \times 10^4 = 0.3 \times 10^5$.
3. $8 + 0.3 = 8.3$, so 8.3×10^5 .
4. Check: $800\,000 + 30\,000 = 830\,000$. ✓

Watch for: Added the coefficients regardless, giving 11×10^5 . This item is the reason item 8 said 'same power' rather than just 'add the fronts'.

7 **SPICY** Is 34×10^4 in the form?

no — 3.4×10^5

1. The form needs exactly one non-zero digit before the point. 34 has two.
2. $34 \times 10^4 = 340\,000$, which is 3.4×10^5 .
3. It is the right NUMBER in the wrong FORM. Both are worth saying — nothing about it is inaccurate.

Watch for: Answered yes because it evaluates correctly. That objection is reasonable and the answer is that the form is a convention about how it is written, not a claim about the value.

9 **EXTRA SPICY** 4×10^{-3} or 9×10^{-4} ?

4×10^{-3} is bigger

1. Expand: 0.004 against 0.0009.
2. With negative powers the LESS negative exponent is the bigger number, whatever the coefficients say.
3. 9 is bigger than 4, and it does not matter — the power decides first.

Watch for: Chose 9×10^{-4} by comparing coefficients. The power dominates, and that is the whole item.

8 **SPICY** $5 \times 10^6 + 2 \times 10^6$

7×10^6 , because 10^6 is a shared unit

1. Five million plus two million is seven million.
2. The 10^6 is what is being counted, so it does not change — like 5 metres plus 2 metres being 7 metres, not 7 square metres.

Watch for: Answered 7×10^{12} . The units comparison is the most reliable way to make this stick.

Homework

8 problems + Mr DJ's worked example

Use: Homework after the practice sheet. Item 7 asks the child to name which law was misapplied rather than just fix the number — that is the difference between correcting an answer and correcting a belief. **Timing:** 20–25 min · independent · items 5, 6 and 8 first when marking.

1 9.1×10^4 and 4×10^{-4}

2 50 000

3 8×10^7

4 3×10^3

5 1.1×10^5

6 2.5×10^8

7 3×10^{-2} is bigger

8 5×10^4 — adding does not touch the power

1 **MILD** 91 000 and 0.0004

9.1×10^4 and 4×10^{-4}

- 91 000: 9.1 with the point moved four places.
- 0.0004: four places right, so 10^{-4} .

Watch for: Wrote 91×10^3 .2 **MILD** A positive power

50 000

- 10^4 means four tens: 5 followed by four zeros.
- 50 000.

Watch for: Miscounted the zeros.3 **MEDIUM** $(4 \times 10^5)(2 \times 10^2)$

8×10^7

- $4 \times 2 = 8$ and $5 + 2 = 7$.

Watch for: Multiplied the powers.4 **MEDIUM** $(9 \times 10^7) \div (3 \times 10^4)$

3×10^3

- $9 \div 3 = 3$ and $7 - 4 = 3$.

Watch for: Subtracted the coefficients.5 **MEDIUM** $6 \times 10^4 + 5 \times 10^4$

1.1×10^5

- Same power, so add the fronts: 11×10^4 .
- 11 is out of range, so renormalise: 1.1×10^5 .
- Check: $60\,000 + 50\,000 = 110\,000$. ✓

Watch for: Left 11×10^4 . This item combines the addition rule with the renormalising step, and the second half is the one usually dropped.6 **MEDIUM** 250×10^6

2.5×10^8

- $250 = 2.5 \times 10^2$.
- So $250 \times 10^6 = 2.5 \times 10^2 \times 10^6 = 2.5 \times 10^8$.
- Check: 250 million is 2.5 hundred-million.

Watch for: Answered 2.5×10^6 , moving the point without compensating in the power. Every place the point moves left must add one to the exponent.7 **SPICY** 3×10^{-2} or 8×10^{-3} ?

3×10^{-2} is bigger

- 0.03 against 0.008.
- The power decides first: -2 is less negative than -3 , so the first is ten times the scale of the second.
- The coefficient 8 being bigger than 3 does not matter.

Watch for: Chose 8×10^{-3} .8 **SPICY** Correct Omar

5×10^4 — adding does not touch the power

- He has used the multiplication law where nothing is multiplied.
- 2 lots of 10^4 plus 3 lots of 10^4 is 5 lots of 10^4 .
- Check: $20\,000 + 30\,000 = 50\,000$, which is 5×10^4 . His answer is 500 000 000.
- The law is real; it just does not apply here.

Watch for: Corrected the answer without naming which law was misapplied. Naming it is what stops the error returning, because the child did have a reason.**Exit Ticket**

4 problems

Use: End of the scientific notation lesson. 5–8 min, independent. Item 4 is the diagnostic and the explanation is what to mark — a child can write 7×10^5 by pattern and still believe the exponents combine. **Timing:** 5–8 min · independent.

1 6.5×10^6 and 0.002 2 8×10^8 3 about 3.3×10^5 times, roughly 300 000

4 7×10^5 , because the power is a shared unit

1 MILD 6 500 000 and 2×10^{-3}

6.5×10^6 and 0.002

1. 6 500 000: one digit before the point gives 6.5, and the point moved six places, so 10^6 .
2. $2 \times 10^{-3} = 2 \div 1000 = 0.002$.

Watch for: Wrote 65×10^5 , which is the right number in the wrong form; or gave -2000 for the negative power.

2 MEDIUM $(2 \times 10^3)(4 \times 10^5)$

8×10^8

1. Coefficients: $2 \times 4 = 8$.
2. Powers: $3 + 5 = 8$, so 10^8 .
3. 8×10^8 is already in proper form.

Watch for: Multiplied the powers to get 10^{15} , or added the coefficients.

3 MEDIUM Sun against Earth

about 3.3×10^5 times, roughly 300 000

1. How many times as much means DIVIDE.
2. Coefficients: $2 \div 6 = 0.33\ldots$
3. Powers: $30 - 24 = 6$, so 10^6 .
4. $0.33 \times 10^6 = 3.3 \times 10^5$, about 330 000 times. Accept “about 3×10^5 ”.
5. Note the coefficient needed renormalising — 0.33 is not one non-zero digit before the point.

Watch for: Subtracted the coefficients to get 4, or subtracted the powers and stopped without dividing the fronts. Or left 0.33×10^6 , which is the right number in the wrong form.

4 SPICY $3 \times 10^5 + 4 \times 10^5$

7×10^5 , because the power is a shared unit

1. Both terms are counts of the same thing: 3 lots of 10^5 and 4 lots of 10^5 .
2. 3 of something plus 4 of something is 7 of it. The something does not change.
3. So $7 \times 10^5 = 700\,000$.
4. Check: $300\,000 + 400\,000 = 700\,000$. ✓
5. 7×10^{10} would be 70 000 000 000 — a hundred thousand times too big.
6. The add-the-exponents law belongs to MULTIPLICATION. Here nothing is being multiplied.

Watch for: Answered 7×10^{10} . This is a real law used outside its conditions, so the child has a reason and needs the conditions named rather than the rule repeated. Expanding to ordinary numbers is the fastest correction.

Lesson slides

teaching notes & timing

Slide	Time	What to do
1	0:00	Frame the exponent as a COUNT of tens from the start. Almost every error on this topic comes from reading it as a size instead.
2	1:00	The form. Insist on exactly one non-zero digit before the point, and be explicit that 34×10^4 is the right NUMBER in the wrong FORM — children reasonably object that it is equal, and it is.
3	2:30	Negative powers. Say “small” and never “negative”. Links straight back to reciprocals in the exponents lesson.
4	4:00	Multiplying, which follows the index law they already have.
5	5:30	THE slide. Adding does NOT touch the power. Write both the right and the wrong answer up and leave them there.
6	7:00	Now expand both to ordinary numbers so the size of the error is visible. A factor of a hundred thousand is more persuasive than any rule.
7	8:30	How-many-times-as-much is a DIVISION. Children subtract the coefficients because the phrase sounds like a difference.
8		Show the problem and the slip. Pairs: what went wrong, and what is the right answer? Take two answers before moving on.
9		

Solve it together, one step at a time. It is also the worked example at the top of the practice sheet, so students can look back at it.

10	10:00	Two conversions and a comparison, then the exit ticket. Whiteboards: everyone tries Mild, then climbs. These are #1, #3, #7 on the practice sheet.
11		Fingers up: 3 = got it, 2 = almost, 1 = not yet. Pull the 1s for a quick reteach while everyone else starts the practice sheet.
12		Launch the practice sheet. Exit ticket in the last 5–8 minutes.