IB Maths | Paper 1 & 2 | ~15 min read

Standard Form

Hi! In this lesson we cover **standard form** — also called **scientific notation**. By the end you'll be writing massive numbers like the distance to the sun, and tiny numbers like the size of an atom, in just a few characters. Let's go.

■ What you need to know

- Standard form means writing a number as $a \times 10^n$
- **a** must be between 1 and 10 (so $1 \le a < 10$)
- **n is positive** for big numbers, **n is negative** for tiny numbers
- n tells you **how many places the decimal moved** — and which direction
- Use it to multiply, divide, add, and subtract huge or tiny numbers easily

Why does standard form even exist?

Imagine writing the mass of the Earth: **5 970 000 000 000 000 000 000 000 kg**. Now the mass of an electron: **0.000 000 000 000 000 000 000 000 000 000 911 kg**. Painful, right? One miscount and the whole answer is wrong. Standard form solves this.

Without standard form	With standard form
Mass of Earth = 5 970 000 000 000 000 000 000 000 kg Mass of electron = 0.000 000 000 000 000 000 000 000 000 000 911 kg	Mass of Earth = 5.97×10^{24} kg Mass of electron = 9.11×10^{-31} kg

■■■ ***Teacher note:*** *Think of standard form as a* ***shorthand****. The "$a \times 10^n$" format keeps the meaningful digits at the front, and lets the power of 10 handle all the zeros. Scientists, engineers, and your IB examiners love it.*

What is standard form?

A number is in **standard form** when written as:

$$a \times 10^n \text{ where } 1 \leq a < 10 \text{ and } n \in ■$$

Breaking it down:

- **a** is the front number — always a single digit before the decimal ($1 \leq a < 10$).
- **10^n** — the exponent n can be positive, negative, or zero.
- **n is positive** when the number is bigger than 10 (e.g. 240 or 5 000 000).
- **n is negative** when the number is smaller than 1 (e.g. 0.05 or 0.000003).
- **n = 0** when the number is already between 1 and 10 (since $10^0 = 1$).

■■■ ***Teacher note:*** *The symbol ■ just means "integer" — any whole number, positive, negative, or zero. When an exam question says "give your answer in the form $a \times 10^n$ where $n \in$ ■", they just mean* ***n must be a whole number****. No fractions allowed.*

How do I write a big number in standard form?

Take the number **3 240 000**. Move the decimal point until one digit sits before it.

1. **Spot the decimal point.** In 3 240 000, it sits invisibly at the end → 3240000.
2. **Move the decimal left until a is between 1 and 10.** Land between 3 and 2 → **3.24**.
3. **Count how many places you moved.** Shifted 6 places to the left → **n = 6**.
4. **Write the answer:** 3 240 000 = $\mathbf{3.24 \times 10^6}$

Sanity-check: $3.24 \times 1\,000\,000 = 3\,240\,000$. ✓

■■■ ***Teacher note: Memory trick:*** *for big numbers, the decimal moves* ***LEFT*** *and n is* ***POSITIVE****. Big number → big positive power.*

How do I write a small number in standard form?

Take **0.000567**. Same idea but the decimal moves the other way.

1. **Find the decimal point** — right at the start: 0.000567.
2. **Move it RIGHT until a is between 1 and 10.** Slide past zeros → **5.67**.
3. **Count the moves.** Shifted 4 places to the right → **n = –4**.
4. **Write the answer:** 0.000567 = $\mathbf{5.67 \times 10^{-4}}$

Check: $5.67 \times 10^{-4} = 5.67 \div 10\,000 = 0.000567$. ✓

> ■■■ ***Teacher note: The pattern in one line:*** *Decimal moves LEFT → n is POSITIVE. Decimal moves RIGHT → n is NEGATIVE. The number of moves IS the value of n.*

Quick examples

1. **100 000** → decimal moves 5 left → $\mathbf{1 \times 10^{5}}$
2. **0.00001** → decimal moves 5 right → $\mathbf{1 \times 10^{-5}}$
3. **4 057.52** → decimal moves 3 left → $\mathbf{4.05752 \times 10^{3}}$
4. **0.00107** → decimal moves 3 right → $\mathbf{1.07 \times 10^{-3}}$
5. **7** → already between 1 and 10 → $\mathbf{7 \times 10^{0}}$ (since $10^{0} = 1$)

Converting back to normal numbers:

- 4.501×10^{7} → move decimal 7 places right → **45 010 000**
- 4.501×10^{-7} → move decimal 7 places left → **0.000 000 4501**

How do I multiply numbers in standard form?

> ■■■ ***Teacher note: The big idea:*** *multiply the front numbers normally, and* ***add the powers****. Two operations.*

Example: $\mathbf{(3 \times 10^{2}) \times (4 \times 10^{5})}$

1. **Multiply the "a" parts:** $3 \times 4 = 12$
2. **Add the powers:** $10^2 \times 10^5 = 10^7$
3. **Put together:** 12×10^7
4. **Fix "a"** — 12 isn't between 1 and 10. Rewrite as 1.2×10^1.
5. Final answer: **1.2×10^8** ✓

How do I divide numbers in standard form?

Same idea but **subtract the powers**. Example: **$(2 \times 10^{-3}) \div (8 \times 10^{-5})$**

1. **Divide the "a" parts:** $2 \div 8 = 0.25$
2. **Subtract the powers:** $10^{-3} \div 10^{-5} = 10^{-3-(-5)} = 10^2$
3. **Put together:** 0.25×10^2
4. **Fix "a"** — 0.25 isn't between 1 and 10. Rewrite as 2.5×10^{-1}.
5. Final answer: **2.5×10^1** (= 25) ✓

> ■■■ ***Teacher note: Watch the signs!*** *When you subtract a negative power it becomes positive. $10^{-3} \div 10^{-5} = 10^{-3+5} = 10^2$. This is the most common place students lose marks — slow down here.*

How do I add or subtract in standard form?

Adding and subtracting is different — you **cannot** just add the powers. Both numbers must have the **same power of 10** before you add or subtract them.

Example with positive powers

Same powers (easy case): $x = 3 \times 10^7$, $y = 4 \times 10^7$

1. Both have 10^7, so just add "a" parts: $3 + 4 = 7$
2. Answer: **7×10^7**

Different powers: $x = 3 \times 10^7$, $y = 4 \times 10^9$. Find $x + y$:

1. **Pick the highest power:** 10^9
2. **Rewrite the smaller one:** $3 \times 10^7 = 0.03 \times 10^9$
3. **Add:** $0.03 \times 10^9 + 4 \times 10^9 = 4.03 \times 10^9$
4. Final answer: **4.03×10^9** ✓

Example with negative powers

Find: **$(8 \times 10^{-20}) - (5 \times 10^{-21})$**

1. Highest power = 10^{-20} (because $-20 > -21$)
2. Rewrite: $5 \times 10^{-21} = 0.5 \times 10^{-20}$
3. Subtract: $(8 - 0.5) \times 10^{-20} = 7.5 \times 10^{-20}$
4. Answer: **7.5×10^{-20}** ✓

■ Examiner Tips and Tricks

- **Use your GDC for the heavy lifting.** Set your calculator to scientific mode and it will automatically display answers in standard form.
- **Watch out for E-notation!** Your calculator might display "6.5E5" instead of 6.5×10^5. In your exam answer always rewrite it cleanly.
- **3 significant figures is your friend.** The IB usually wants final answers to 3 s.f. So 1.2345×10^2 becomes 1.23×10^2.

Worked Example

Calculate the following, giving your answer in the form $a \times 10^n$, where $1 \le a < 10$ and $n \in$ ■.

✎ Worked Example

i) 3 780 × 200

GDC (scientific mode): 3 780 × 200 = 7.56×10^5

Without GDC: 3 780 × 200 = 756 000 → convert →

7.56 × 10■

ii) (7 × 10■) – (5 × 10■)

GDC: $7 \times 10^5 - 5 \times 10^4 = 6.5 \times 10^5$ (may show as 6.5E5)

Without GDC: 700 000 – 50 000 = 650 000 → convert →

6.5 × 10■

iii) (3.6 × 10■³)(1.1 × 10■■)

$10^{-3} \times 10^{-5} = 10^{-8}$ (add powers)

3.6 × 1.1 = 3.96 (multiply "a" parts)

3.96 × 10■■

iv) (4 × 10■■) + (2 × 10■■)

Highest power: 10^{50}. Rewrite: $2 \times 10^{48} = 0.02 \times 10^{50}$

Add: $4 \times 10^{50} + 0.02 \times 10^{50}$ =

4.02 × 10■■

■ Common Mistakes

- **Leaving "a" outside 1 ≤ a < 10.** Writing 12×10^5 or 0.5×10^3 loses marks. Always check!
- **Adding/subtracting powers on plus or minus.** The "add powers" rule is for multiplication only.
- **Forgetting to subtract powers when dividing.** $10^{-3} \div 10^{-5}$ is 10^2, not 10^{-8}.
- **Confusing the direction of decimal jumps.** Big number = decimal LEFT; small number = decimal RIGHT.
- **Misreading E-notation.** 6.5E5 means 6.5×10^5, not 6.5 × 5.
- **Mixing up negative powers.** 10^{-20} is BIGGER than 10^{-21} because –20 > –21.

> ■■■ ***Teacher note: Final word:*** *standard form looks intimidating because of all the powers, but it's literally just decimal-shifting + a tiny bit of arithmetic. Once you've practised 10–15 questions it becomes muscle memory. Trust the steps, check your "a" is between 1 and 10, and you'll fly through these in the exam.*