Standard Form

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What is Standard Form?

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

$$a \times 10^n$$

- a: a number where $1 \leq a < 10$ (one non-zero digit before the decimal point).
- n: an integer (positive, negative, or zero).
- **Large numbers** (≥ 10) $\Rightarrow$ n is **positive**.
- **Small numbers** (< 1) $\Rightarrow$ n is **negative**.

Converting TO Standard Form

1. Place decimal after first non-zero digit $\rightarrow$ gives a.
2. Count places the decimal moved $\rightarrow$ gives $|n|$.
3. Moved **LEFT** $\Rightarrow$ n positive (big number).
   Moved **RIGHT** $\Rightarrow$ n negative (small number).

Examples:
$4\,700\,000 = 4.7 \times 10^6$ (6 left)
$0.00061 = 6.1 \times 10^{-4}$ (4 right)

Converting FROM Standard Form

Move the decimal point:

- **Positive** power $\Rightarrow$ move decimal **RIGHT**.
- **Negative** power $\Rightarrow$ move decimal **LEFT**.
- **Zero** power $\Rightarrow$ decimal stays ($10^0 = 1$).

Examples:
$6.4 \times 10^5 = 640\,000$
$2.07 \times 10^{-3} = 0.00207$

Ordering & Comparing

1. Compare **powers of 10** first.
2. Larger power = larger number.
3. Same power? Compare the a values.

Watch out with negatives:
$-2 > -3$, so $10^{-2} > 10^{-3}$.
Therefore $2.4 \times 10^{-2} > 9.8 \times 10^{-3}$
even though $9.8 > 2.4$.

Calculations in Standard Form

Multiply: $(a \times 10^m) \times (b \times 10^n) = (a \times b) \times 10^{m+n}$ Multiply a's, **ADD** powers

Divide: $(a \times 10^m) \div (b \times 10^n) = \left(\frac{a}{b}\right) \times 10^{m-n}$ Divide a's, **SUBTRACT** powers

Add/Sub: Make powers the **SAME** first, then add/subtract the a's. *Or*: convert to ordinary numbers.

Golden Rule: After every calculation, check $1 \leq a < 10$. If not, **adjust**!

The Adjustment Step (Most Common Mark Lost!)

If $a \times b \geq 10$: move decimal left, increase power. If $a \div b < 1$: move decimal right, decrease power.

$27 \times 10^{10} \longrightarrow 2.7 \times 10^{11}$ $0.4 \times 10^{-2} \longrightarrow 4 \times 10^{-3}$

$31.5 \times 10^{-3} \longrightarrow 3.15 \times 10^{-2}$ $0.5 \times 10^{3} \longrightarrow 5 \times 10^{2}$

Calculator Tips

Use the **EXP** (or $\times 10^x$ or **EE**) button.

- 3.2×10^5: press `3.2 EXP 5`
- 4.7×10^{-3}: press `4.7 EXP (-) 3`
- **Never** type `× 10 × EXP`! This multiplies by an extra 10.

Reading displays:
`3.2 05` and `3.2E5` both mean 3.2×10^5.

Real-World Problem Keywords

Standard form appears in problems involving:

- **Astronomy:** planetary distances, signal speeds.
- **Biology:** sizes of bacteria, cells, viruses.
- **Population:** country totals, comparisons.
- **Measurement:** large areas, atomic masses.

Always check the **units** in your answer!

Common Traps & Pitfalls

1. **Not Standard Form:** 32×10^4 is wrong ($a = 32 \geq 10$). Correct: 3.2×10^5. Similarly $0.5 \times 10^6 = 5 \times 10^5$.
2. **Wrong Direction:** Positive power $\rightarrow$ RIGHT. Negative power $\rightarrow$ LEFT. $3.5 \times 10^{-2} = 0.035$, **not** 350!
3. **Adding Powers:** $(3 \times 10^4) + (2 \times 10^3) \neq 5 \times 10^7$. Match powers first! Correct: 3.2×10^4.
4. **Calculator:** Don't type `× 10 × EXP`. Just use `EXP`. Always check $1 \leq a < 10$ before writing final answer!

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