

Standard form calculations without a calculator

Starter

- (Review of last lesson)** Convert to standard form:
(a) 0.00000192 (b) 64×10^8 (c) 0.25×10^{-6}
- (Review of last lesson)** Convert 4.39×10^{-3} to an ordinary number
- A rich relative leaves his fortune of $\pounds(3.6 \times 10^8)$ to his 100 relatives. How much do they each get? Give your answer as an ordinary number.
- (a) Using the laws of indices, write $10^4 \times 10^9$ as a power of 10.
(b) Hence, find the value of these calculations, giving your answer in standard form:
(i) $(2 \times 10^4) \times (3 \times 10^9)$ (ii) $(2 \times 10^4) \times (8 \times 10^9)$

Notes

The laws of indices are used in calculations with standard form.

Success criteria – multiplying numbers expressed in standard form

- Multiply the non-index parts.
- Add the indices.
- If necessary, convert into standard form.

E.g. 1 Without a calculator, find the value of:

(a) $(6 \times 10^5) \times (7 \times 10^8)$ (b) $(8 \times 10^{-6}) \times (9 \times 10^4)$

Give your answers in standard form.

Working: (a) $(6 \times 10^5) \times (7 \times 10^8) = (6 \times 7) \times 10^{5+8}$
 $= 42 \times 10^{13}$
 $= 4.2 \times 10 \times 10^{13}$
 $= 4.2 \times 10^{1+13}$ *remember $10 = 10^1$*
 $= 4.2 \times 10^{14}$

Division involving standard form

- E.g. 2** (a) Using the laws of indices, write $10^{18} \div 10^{11}$ as a power of 10.
(b) Hence, find the value of these calculations, giving your answer in standard form:
(i) $(4 \times 10^{18}) \div (2 \times 10^{11})$ (ii) $(2 \times 10^{18}) \div (4 \times 10^{11})$

Working: (a) $10^{18} \div 10^{11} = 10^{18-11} = 10^7$

Success criteria – dividing numbers expressed in standard form

- Divide the non-index parts.
- Subtract the indices.
- If necessary, convert into standard form.

E.g. 3 Without a calculator, find the value of:

(a) $(9 \times 10^8) \div (3 \times 10^2)$ (b) $(2 \times 10^4) \div (8 \times 10^{-5})$

Give your answers in standard form.

Working: (a) $(9 \times 10^8) \div (3 \times 10^2) = (9 \div 3) \times 10^{8-2} = 3 \times 10^6$

N.B. Be careful when the two non-index numbers multiply or divide to give a number outside the range of $1 \leq A < 10$.

Exercise

9-1 class textbook: p131 M5.4 Qu 1ace..., 2ace...3ace..., 4-9

A*-G class textbook: p123 M5.4 Qu 1ace..., 2ace...3ace..., 4-9

9-1 homework book: p45 M5.4 Qu 1ace, 2, 3ace

A*-G homework book: p33 M5.4 Qu 1ace, 2, 3ace

Addition and subtraction of numbers in standard form

Case 1 – the powers of 10 are equal

E.g. 4 By expressing the numbers as ordinary numbers, evaluate $(3 \times 10^4) + (6 \times 10^4)$ without a calculator. What do you notice about your answer to (a)?

It is possible to convert both numbers in standard form to ordinary numbers and then add or subtract them. However, this is cumbersome when the power of 10 are very large or very small.

E.g. $(3 \times 10^{12}) + (6 \times 10^{12})$

In such cases we can simply add the number and keep the powers of 10 the same.

$(3 \times 10^{12}) + (6 \times 10^{12}) = (3 + 6) \times 10^{12} = 9 \times 10^{12}$

Be careful when the sum of the two numbers gives a number that is greater than 10.

E.g. $(7 \times 10^{23}) + (5 \times 10^{23}) = 12 \times 10^{23} = 1.2 \times 10 \times 10^{23} = 1.2 \times 10^{24}$

Case 2 – the powers of 10 are different

It becomes more complicated from the powers of 10 are different. In such cases, convert the number(s) with the smaller power of 10 to the highest power of 10.

E.g. $(2 \times 10^{17}) + (4 \times 10^{16})$ *we wouldn't want to write down 34 zeros*

We need to change 4×10^{16} to "a number $\times 10^{17}$ "

$4 \times 10^{16} = 4 \times 10^{17-1}$

$= 4 \times 10^{17} \times 10^{-1}$

$= 4 \times 10^{17} \times \frac{1}{10}$

$= 0.4 \times 10^{17}$

So $(2 \times 10^{17}) + (4 \times 10^{16}) = (2 \times 10^{17}) + (0.4 \times 10^{17}) = 2.4 \times 10^{17}$

Success criteria – adding and subtracting numbers in standard form

1. Make sure the numbers have the same power of 10 as the highest power.
2. Add/subtract the non-index numbers.
3. Leave the index numbers as they are.
4. If necessary, convert the answer to standard form.

E.g. 5 Without a calculator, find the value of:

(a) $(5 \times 10^9) + (3 \times 10^8)$ (b) $(6.2 \times 10^{-7}) + (4.9 \times 10^{-8})$
(c) $(5.2 \times 10^4) - (3.3 \times 10^3)$ (d) $(3.6 \times 10^7) - (9.4 \times 10^6)$

Working:

(a) $(5 \times 10^9) + (3 \times 10^8) = (5 \times 10^9) + (0.3 \times 10^9)$
 $= (5 + 0.3) \times 10^9$
 $= 5.3 \times 10^9$

(b) $(6.2 \times 10^{-7}) - (4.9 \times 10^{-8}) = (6.2 \times 10^{-7}) - (0.49 \times 10^{-7})$
 $= (6.2 - 0.49) \times 10^{-7}$
 $= 5.71 \times 10^{-7}$

(c) $(8 \times 10^{13}) - (6 \times 10^{12}) = (8 \times 10^{13}) - (0.6 \times 10^{13})$
 $= (8 - 0.6) \times 10^{13}$
 $= 7.4 \times 10^{13}$

(d) $(2.5 \times 10^{-25}) + (3 \times 10^{-26}) = (2.5 \times 10^{-25}) + (0.3 \times 10^{-25})$
 $= (2.5 + 0.3) \times 10^{-25}$
 $= 2.8 \times 10^{-25}$

Video: [Standard form multiplication \(no calculator\)](#)
Video: [Standard form division \(no calculator\)](#)
Video: [Standard form addition \(no calculator\)](#)

[Solutions to Starter and E.g.s](#)

Exercise

9-1 class textbook: p131 M5.4 Qu 10, 11ace..., 12-18
A*-G class textbook: p123 M5.4 Qu 10, 11ace..., 12-15
9-1 homework book: p45 M5.4 Qu 4-10
A*-G homework book: p33 M5.4 Qu 4-8

Summary

Success criteria – multiplying numbers expressed in standard form

1. Multiply the non-index parts.
2. Add the indices.
3. If necessary, convert into standard form.

Success criteria – dividing numbers expressed in standard form

1. Divide the non-index parts.
2. Subtract the indices.
3. If necessary, convert into standard form.

Success criteria – adding and subtracting numbers in standard form

1. Make sure the numbers have the same power of 10 as the highest power.
2. Add/subtract the non-index numbers.
3. Leave the index numbers as they are.
4. If necessary, convert the answer to standard form.