

Standard form calculations without a calculator

Starter

1. **(Review of last lesson)** Convert to standard form:

- (a) 0.00000192 (b) 64×10^8 (c) 0.25×10^{-6}

Working:

(a) $0.00000192 = 1.92 \times 10^{-6}$

(b) $64 \times 10^8 = 6.4 \times 10 \times 10^8 = 6.4 \times 10^{1+8} = 6.4 \times 10^9$

(c) $0.25 \times 10^{-6} = 2.5 \div 10 \times 10^{-6}$
 $= 2.5 \times 10^{-1} \times 10^{-6}$
 $= 2.5 \times 10^{-1+(-6)}$
 $= 2.5 \times 10^{-7}$

2. **(Review of last lesson)** Convert 4.39×10^{-3} to an ordinary number

Working: $4.39 \times 10^{-3} = 4.39 \times \frac{1}{1000} = \frac{4.39}{1000} = 0.00439$

3. 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.

Working: $(3.6 \times 10^8) \div 100 = (3.6 \times 10^8) \div 10^2 = 3.6 \times 10^6 = 3600000$
 Each relative gets $\pounds 3600000$.

4. (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) $(2 \times 10^4) \times (8 \times 10^9)$

Working:

(a) $10^4 \times 10^9 = 10^{4+9} = 10^{13}$

(b) (i) $(2 \times 10^4) \times (3 \times 10^9) = (2 \times 3) \times 10^{4+9} = 6 \times 10^{13}$

(ii) $(2 \times 10^4) \times (8 \times 10^9) = (2 \times 8) \times 10^{4+9} = 16 \times 10^{13}$
 But 16×10^{13} is not in standard form.
 $16 \times 10^{13} = (1.6 \times 10) \times 10^{13} = 1.6 \times 10^{14}$

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 $10 = 10^1$*
 $= 4.2 \times 10^{14}$

$$\begin{aligned} \text{(b)} \quad (8 \times 10^{-6}) \times (9 \times 10^4) &= (8 \times 9) \times 10^{-6+4} \\ &= 72 \times 10^{-10} \\ &= 7.2 \times 10 \times 10^{-10} \\ &= 7.2 \times 10^{1+-10} \quad \text{remember } 10 = 10^1 \\ &= 7.2 \times 10^{-9} \end{aligned}$$

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:

$$\text{(i)} \quad (4 \times 10^{18}) \div (2 \times 10^{11}) \qquad \text{(ii)} \quad (2 \times 10^{18}) \div (4 \times 10^{11})$$

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

(b) (i) $(4 \times 10^{18}) \div (2 \times 10^{11}) = (4 \div 2) \times 10^{18-11} = 2 \times 10^7$

(ii) $(2 \times 10^{18}) \div (4 \times 10^{11}) = (2 \div 4) \times 10^{18-11} = 0.5 \times 10^7$

But 0.5×10^7 is not in standard form.

$$\begin{aligned} 0.5 \times 10^7 &= (5 \div 10) \times 10^6 \\ &= 5 \times 10^{-1} \times 10^6 \\ &= 5 \times 10^{-1+6} \\ &= 5 \times 10^5 \end{aligned}$$

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

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

Give your answers in standard form.

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

(b) $(2 \times 10^4) \div (8 \times 10^{-5}) = (2 \div 8) \times 10^{4--5} = 0.25 \times 10^9$

But 0.25×10^9 is not in standard form.

$$\begin{aligned} 0.25 \times 10^9 &= (2.5 \div 10) \times 10^9 \\ &= 2.5 \times 10^{-1} \times 10^9 \\ &= 2.5 \times 10^{-1+9} \\ &= 2.5 \times 10^8 \end{aligned}$$

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)?

Working: $(3 \times 10^4) + (6 \times 10^4) = 30000 + 60000 = 90000 = 9 \times 10^4$
For (a) the power of 10 of both the numbers and the answer are the same.

Case 2 – the powers of 10 are different

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) $(6.2 \times 10^{-7}) + (4.9 \times 10^{-8}) = (6.2 \times 10^{-7}) + (0.49 \times 10^{-7})$
 $= (6.2 + 0.49) \times 10^{-7}$
 $= 6.69 \times 10^{-7}$

(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) $(2.5 \times 10^{-25}) - (3 \times 10^{-26}) = (2.5 \times 10^{-25}) - (0.3 \times 10^{-25})$
 $= (2.5 - 0.3) \times 10^{-25}$
 $= 2.2 \times 10^{-25}$

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