

Standard form

Revision questions: worked solutions

Writing large and small numbers in standard form

Remember: One digit before the point, then count the jumps.

Q1. One digit before the point: 7.25. The 7 is in the 10^4 column, so it jumps 4 places to get back to the ones column.

$$72\,500 = 7.25 \times 10^4$$

Q2. (a) $6000 = 6 \times 10^3$ (3 jumps) (b) $3\,080\,000 = 3.08 \times 10^6$ (6 jumps)

(c) $0.009 = 9 \times 10^{-3}$ (3 jumps, and a small number has a negative power)

(d) $0.000\,304 = 3.04 \times 10^{-4}$ (4 jumps)

Q3. (a) $3 \times 10^6 = 3\,000\,000$ (b) $2.07 \times 10^4 = 20\,700$

(c) $5 \times 10^{-2} = 0.05$ (d) $6.1 \times 10^{-5} = 0.000\,061$

A positive power gives a big number; a negative power gives a number less than 1.

Q4. The first number must be from 1 up to, but not including, 10.

34×10^5 : 34 is too big. $34 = 3.4 \times 10^1$, so $34 \times 10^5 = 3.4 \times 10^6$.

0.7×10^3 : 0.7 is too small. $0.7 \times 10^3 = 700 = 7 \times 10^2$.

Q5. $58\,000\,000 = 5.8 \times 10^7$ km (7 jumps)

Q6. Compare the powers first: 10^{-6} is the smallest, then 10^{-5} , 10^{-4} , 10^{-3} .

Smallest first: red blood cell (8×10^{-6}), human hair (7×10^{-5}), grain of sand (5×10^{-4}), ant (4×10^{-3}).

Multiplying and dividing in standard form

Remember: Numbers with numbers, powers with powers.

Q7. Multiplying: add the powers. Dividing: subtract the powers.

(a) $2 \times 4 = 8$, $10^3 \times 10^5 = 10^8$: 8×10^8

(b) $5 \times 3 = 15$, $10^6 \times 10^{-2} = 10^4$: $15 \times 10^4 = 1.5 \times 10^5$

(c) $9 \div 3 = 3$, $10^8 \div 10^2 = 10^6$: 3×10^6

(d) $2 \div 8 = 0.25$, $10^{-3} \div 10^4 = 10^{-7}$: $0.25 \times 10^{-7} = 2.5 \times 10^{-8}$

Q8. $(1 \times 10^{-4}) \times (5 \times 10^3) = 5 \times 10^{-1}$ m, which is 0.5 m.

Q9. Distance = speed $\times$ time: $(3 \times 10^5) \times (2 \times 10^3) = 6 \times 10^8$ km

Adding and subtracting in standard form

Remember: Can't add powers: change to ordinary numbers first.

Q10. (a) $60\,000 + 3\,000 = 63\,000 = 6.3 \times 10^4$

(b) $8\,500\,000 - 400\,000 = 8\,100\,000 = 8.1 \times 10^6$

(c) $0.002 + 0.0006 = 0.0026 = 2.6 \times 10^{-3}$

(d) $0.07 - 0.005 = 0.065 = 6.5 \times 10^{-2}$

Q11. Ben added the numbers ($3 + 2 = 5$) and added the powers ($4 + 3 = 7$). Powers are only added when we multiply. Change to ordinary numbers first:

$$30\,000 + 2\,000 = 32\,000 = 3.2 \times 10^4$$

Q12. $143\,000 - 12\,700 = 130\,300 = 1.303 \times 10^5$ km

Standard form with a calculator

Remember: Use the $\times 10^x$ key; it already includes the ' $\times 10$ '.

Q13. (a) $302\,400 = 3.024 \times 10^5$

(b) $5\,625\,000\,000 = 5.625 \times 10^9$

(c) $800\,000\,000 = 8 \times 10^8$

(d) $\sqrt{49\,000\,000} = 7\,000 = 7 \times 10^3$

Check (a) without the calculator: $6.3 \times 4.8 \approx 30$ and $10^7 \times 10^{-3} = 10^4$, so the answer is about $30 \times 10^4 = 3 \times 10^5$.

Q14. The calculator works from left to right. With no brackets, Ava's keys work out $4 \times 10^3 = 4000$, then $4000 \div 2 = 2000$, then $2000 \times 10^2 = 200\,000$. It has multiplied by 10^2 instead of dividing by it.

Ava should put brackets round each number, or use the $\times 10^x$ key, which keeps each number together:

$$(4 \times 10^3) \div (2 \times 10^2) = 4000 \div 200 = 20$$

Problems with standard form

Remember: Right formula, numbers in, answer in standard form.

Q15. Time = $\frac{\text{distance}}{\text{speed}} = \frac{3.84 \times 10^8}{3 \times 10^8} = 1.28$ seconds

($3.84 \div 3 = 1.28$ and $10^8 \div 10^8 = 10^0 = 1$)

Q16. Distance = speed $\times$ time = $(1.1 \times 10^4) \times (3.6 \times 10^3) = 3.96 \times 10^7$ m

Q17. $\frac{2 \times 10^{-2}}{8 \times 10^{-6}} = 0.25 \times 10^4 = 2.5 \times 10^3 = 2500$ red blood cells

Q18. $\frac{6.8 \times 10^7}{2.4 \times 10^5} = 2.833 \dots \times 10^2 = 283.3 \dots$, which is 280 to 2 significant figures (2.8×10^2).

Q19. $\frac{5.97 \times 10^{24}}{7.35 \times 10^{22}} = 0.8122 \dots \times 10^2 = 81.22 \dots$, so the Earth is about 81 times heavier.

Problem solving

Q20. Time in seconds: $\frac{1.2 \times 10^{14}}{3 \times 10^9} = 0.4 \times 10^5 = 4 \times 10^4$ seconds.

There are $60 \times 60 = 3600$ seconds in an hour: $40\,000 \div 3600 = 11.1 \dots$, so 11.1 hours.

Q21. The numbers multiply to 6 and the powers add to 5. For example

$$(2 \times 10^2) \times (3 \times 10^3) \quad (1.5 \times 10^1) \times (4 \times 10^4) \quad (6 \times 10^{-1}) \times (1 \times 10^6)$$

Q22. $(2 \times 10^3)^3 = 2^3 \times 10^9 = 8 \times 10^9$, and $10^{10} = 10 \times 10^9$. So 10^{10} is bigger.