



Standard Form

IB Mathematics: Analysis and Approaches SL & HL - Topic 1: Number and Algebra

50 questions on writing, comparing and operating with numbers of the form $a \times 10^k$

Learning goal	Write numbers in standard form and carry out arithmetic accurately with numbers of the form $a \times 10^k$, where $1 \leq a < 10$ and $k \in \mathbb{Z}$.
Syllabus link	IB Mathematics AA SL/HL: SL 1.1 - operations with numbers in the form $a \times 10^k$.
Structure	Section 1: 15 short-response questions; Section 2: 15 extended-response questions; Section 3: 20 original IB Paper 1-style questions.
Calculator / technology	Sections 1-2 may be checked with technology. Section 3 is designed to be completed without a calculator. Calculator/computer notation such as 5.2E30 is not acceptable as final mathematical notation.

Instructions. Unless a question states otherwise, give final numerical answers in standard form, with $1 \leq a < 10$. Show enough working to make the exponent arithmetic clear. In contextual questions, include units where appropriate.

Section 1 - Short response

Questions 1-15

1. Write 4 730 000 in standard form.

2. Write 0.0000812 in standard form.

3. Write 6.04×10^7 as an ordinary number.

4. Write 3.9×10^{-6} as an ordinary decimal.

5. Rewrite 0.72×10^9 in standard form.

6. Rewrite 34.5×10^{-4} in standard form.

7. Evaluate $(3 \times 10^5)(4 \times 10^3)$.



8. Evaluate $\frac{8.4 \times 10^7}{2.1 \times 10^3}$.

9. Evaluate $(6 \times 10^{-4})(5 \times 10^{-7})$.

10. Evaluate $\frac{9.6 \times 10^{-2}}{3.2 \times 10^4}$.

11. Evaluate $2.7 \times 10^6 + 5.4 \times 10^5$.

12. Evaluate $8.1 \times 10^{-3} - 2.6 \times 10^{-4}$.

13. Evaluate $(2 \times 10^3)^3$.

14. State which is greater: 7.2×10^{-5} or 6.9×10^{-4} .

15. A calculator displays 5.2E30. Write this number using acceptable mathematical standard-form notation.

Section 2 - Extended response**Questions 16-30**

16. Evaluate

$$\frac{(4.8 \times 10^7)(2.5 \times 10^{-3})}{6 \times 10^2}.$$

17. Evaluate

$$\frac{3.6 \times 10^{-5} + 8.4 \times 10^{-6}}{1.2 \times 10^{-4}}.$$

Give your answer in standard form.

18. The mean distance from Earth to the Moon is approximately 3.84×10^8 m. The radius of Earth is approximately 6.4×10^6 m. Estimate the Earth-Moon distance as a multiple of Earth's radius.

19. A microscopic layer has thickness 7.5×10^{-6} m. Find the total thickness of 1.2×10^5 identical layers placed one on top of another.

20. A data centre contains 7.5×10^4 storage drives. Each drive stores 2.4×10^{12} bytes. Find the total number of bytes that can be stored.



21. One light-year is approximately 9.46×10^{15} m. A star is 4.2 light-years away. Find its distance from Earth in metres, in standard form.

22. A bacterium is approximately 2.5×10^{-6} m long. How many such bacteria, placed end-to-end, would span 1.2×10^{-3} m?

23. A rectangular solar farm has length 3.2×10^4 m and width 7.5×10^3 m. Find its area in square metres, in standard form.

24. A cube has side length 4×10^{-3} m. Find its volume in cubic metres, in standard form.

25. A population of 8×10^9 people each uses 2.5×10^3 mL of water in one day. Find the total daily water use in millilitres, in standard form.

26. Find x if

$$(3.6 \times 10^8)x = 9 \times 10^{11}.$$

Give x in standard form.

27. A packet has total mass 6×10^{-4} kg. Each grain in the packet has mass 2×10^{-7} kg. Find the number of grains in the packet.

28. A student writes

$$3.5 \times 10^8 + 4.2 \times 10^7 = 7.7 \times 10^{15}.$$

Explain the error and give the correct answer.

29. Arrange the following numbers in ascending order:

$$5.2 \times 10^{-6}, \quad 0.48 \times 10^{-5}, \quad 6.1 \times 10^{-7}, \quad 0.000005.$$

30. A government programme costs 6.3×10^{10} euros and serves 4.5×10^7 people. Find the average cost per person, in euros, in standard form.



31. Let $A = 6 \times 10^8$ and $B = 1.5 \times 10^{-3}$.

(a) Find AB . [2 marks]

(b) Find $\frac{A}{B}$. [2 marks]

32. A radio signal travels at $3 \times 10^8 \text{ m s}^{-1}$. The distance from Earth to a spacecraft is $2.25 \times 10^{11} \text{ m}$.

(a) Find the time, in seconds, taken by the signal to reach the spacecraft. [2 marks]

(b) Express this time in minutes. [1 marks]

33. A bacterium has length $4 \times 10^{-6} \text{ m}$.

(a) Find the number of bacteria that fit end-to-end along a length of $2 \times 10^{-2} \text{ m}$. [2 marks]

(b) Each bacterium has mass $3 \times 10^{-15} \text{ kg}$. Find the total mass of this number of bacteria. [2 marks]

34. A public fund of 8.4×10^{10} euros is divided equally among 2.1×10^7 people. Find the amount allocated per person. [2 marks]

35. Let $P = 2.4 \times 10^5$ and $Q = 5 \times 10^{-3}$. Find PQ^2 , giving your answer in standard form. [3 marks]

36. A small cube has side length $3 \times 10^{-4} \text{ m}$.

(a) Find the volume of one cube. [2 marks]

(b) Find the total volume of 2×10^5 such cubes. [2 marks]

37. Two particles have masses $7.5 \times 10^{-8} \text{ g}$ and $0.92 \times 10^{-7} \text{ g}$. Find the difference between their masses, giving your answer in standard form. [2 marks]

38. A processor completes 4×10^9 operations per second.

(a) Find the number of operations completed in 2.5×10^2 seconds. [2 marks]

(b) Find the time required to complete 5×10^{12} operations. [2 marks]

39. The mass of Earth is approximated by $6 \times 10^{24} \text{ kg}$ and the mass of the Moon by $7.5 \times 10^{22} \text{ kg}$. Find the ratio

$$\frac{\text{mass of Earth}}{\text{mass of Moon}}.$$

Interpret your answer. [3 marks]



40. A calculator display shows $3.6\text{E}-7$.

- (a) Write the number using standard mathematical notation. [1 marks]
- (b) State why the calculator display is not acceptable as the final written answer in this topic. [1 marks]

41. Find x if

$$(4 \times 10^5)x = 1.2 \times 10^{-2}.$$

Give your answer in standard form.

[3 marks]

42. A rectangular field has area $1.8 \times 10^7 \text{ m}^2$ and width $6 \times 10^3 \text{ m}$.

- (a) Find the length of the field. [2 marks]
- (b) Hence find its perimeter, in standard form. [2 marks]

43. The wavelength of a laser is 650 nm, where $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$.

- (a) Write 650 nm in metres, in standard form. [2 marks]
- (b) Find the total length of 2×10^5 wavelengths placed end-to-end. [2 marks]

44. A national debt is 1.26×10^{12} euros. The population is 3.5×10^8 . Find the debt per person, in euros, in standard form. [2 marks]

45. A reservoir contains $2 \times 10^5 \text{ m}^3$ of water. A small droplet has volume $5 \times 10^{-8} \text{ m}^3$. Estimate the number of droplets represented by the reservoir volume. [2 marks]

46. A file contains 3.2×10^9 bytes. Each byte contains 8 bits. Find the number of bits in the file, in standard form. [2 marks]

47. The following equation is true:

$$(5 \times 10^n)(4 \times 10^3) = 2 \times 10^{10}.$$

Find the integer n .

[3 marks]

48. Let $x = 1.2 \times 10^6$ and $y = 3 \times 10^5$. Find

$$\frac{x - y}{x},$$

giving your answer in standard form.

[3 marks]



49. Light travels at approximately $3 \times 10^8 \text{ m s}^{-1}$.

(a) Find the distance travelled in 2×10^4 seconds.

[2 marks]

(b) Find the corresponding round-trip distance.

[1 marks]

50. A square microchip has side length $2.4 \times 10^{-2} \text{ m}$. Each microscopic component occupies a square of side length $8 \times 10^{-6} \text{ m}$.

(a) Find the number of components that fit along one side of the chip.

[2 marks]

(b) Hence estimate the number of components that fit on the whole square chip.

[2 marks]



Answer key and solution outlines

Questions 1-50

Section 1 - Short response

1. 4.73×10^6 .
2. 8.12×10^{-5} .
3. 60 400 000.
4. 0.0000039.
5. 7.2×10^8 .
6. 3.45×10^{-3} .
7. $12 \times 10^8 = 1.2 \times 10^9$.
8. $\frac{8.4}{2.1} \times 10^{7-3} = 4 \times 10^4$.
9. $30 \times 10^{-11} = 3 \times 10^{-10}$.
10. $3 \times 10^{-6} = 3 \times 10^{-6}$.
11. $2.7 \times 10^6 + 0.54 \times 10^6 = 3.24 \times 10^6$.
12. $8.1 \times 10^{-3} - 0.26 \times 10^{-3} = 7.84 \times 10^{-3}$.
13. $8 \times 10^9 = 8 \times 10^9$.
14. 6.9×10^{-4} is greater.
15. 5.2×10^{30} .

Section 2 - Extended response

16. $\frac{(4.8)(2.5)}{6} \times 10^{7-3-2} = 2 \times 10^2 = 2 \times 10^2$.
17. $3.6 \times 10^{-5} + 0.84 \times 10^{-5} = 4.44 \times 10^{-5}$, so $\frac{4.44}{1.2} \times 10^{-1} = 3.7 \times 10^{-1} = 3.7 \times 10^{-1}$.
18. $\frac{3.84 \times 10^8}{6.4 \times 10^6} = 0.6 \times 10^2 = 60$. The distance is about 60 Earth radii.
19. $(7.5 \times 10^{-6})(1.2 \times 10^5) = 9 \times 10^{-1} = 0.9$ m.
20. $(7.5 \times 10^4)(2.4 \times 10^{12}) = 18 \times 10^{16} = 1.8 \times 10^{17}$ bytes.
21. $(9.46 \times 4.2) \times 10^{15} = 39.732 \times 10^{15} = 3.9732 \times 10^{16}$ m.
22. $\frac{1.2 \times 10^{-3}}{2.5 \times 10^{-6}} = 0.48 \times 10^3 = 480 = 4.8 \times 10^2$ bacteria.
23. $(3.2 \times 10^4)(7.5 \times 10^3) = 24 \times 10^7 = 2.4 \times 10^8$ m².
24. $(4 \times 10^{-3})^3 = 64 \times 10^{-9} = 6.4 \times 10^{-8}$ m³.
25. $(8 \times 10^9)(2.5 \times 10^3) = 20 \times 10^{12} = 2 \times 10^{13}$ mL.
26. $x = \frac{9 \times 10^{11}}{3.6 \times 10^8} = 2.5 \times 10^3 = 2.5 \times 10^3$.
27. $\frac{6 \times 10^{-4}}{2 \times 10^{-7}} = 3 \times 10^3 = 3 \times 10^3$ grains.
28. Exponents cannot be added when the operation is addition. Rewrite $4.2 \times 10^7 = 0.42 \times 10^8$. Then $3.5 \times 10^8 + 0.42 \times 10^8 = 3.92 \times 10^8$.



29. $6.1 \times 10^{-7} < 4.8 \times 10^{-6} < 5 \times 10^{-6} < 5.2 \times 10^{-6}$.
30. $\frac{6.3 \times 10^{10}}{4.5 \times 10^7} = 1.4 \times 10^3 = 1.4 \times 10^3$ euros per person.

Section 3 - Original IB Paper 1 style

31. (a) $AB = (6)(1.5) \times 10^{8-3} = 9 \times 10^5 = 9 \times 10^5$.
(b) $\frac{A}{B} = \frac{6}{1.5} \times 10^{8-(-3)} = 4 \times 10^{11} = 4 \times 10^{11}$.
32. (a) $t = \frac{2.25 \times 10^{11}}{3 \times 10^8} = 0.75 \times 10^3 = 750$ s.
(b) $750 \div 60 = 12.5$ minutes.
33. (a) $\frac{2 \times 10^{-2}}{4 \times 10^{-6}} = 0.5 \times 10^4 = 5 \times 10^3$ bacteria.
(b) $(5 \times 10^3)(3 \times 10^{-15}) = 15 \times 10^{-12} = 1.5 \times 10^{-11}$ kg.
34. $\frac{8.4 \times 10^{10}}{2.1 \times 10^7} = 4 \times 10^3 = 4 \times 10^3$ euros.
35. $Q^2 = 25 \times 10^{-6} = 2.5 \times 10^{-5}$, so $PQ^2 = (2.4 \times 10^5)(2.5 \times 10^{-5}) = 6 \times 10^0 = 6 \times 10^0$.
36. (a) $V = (3 \times 10^{-4})^3 = 27 \times 10^{-12} = 2.7 \times 10^{-11}$ m³.
(b) $(2 \times 10^5)(2.7 \times 10^{-11}) = 5.4 \times 10^{-6} = 5.4 \times 10^{-6}$ m³.
37. $0.92 \times 10^{-7} = 9.2 \times 10^{-8}$, so the difference is $(9.2 - 7.5) \times 10^{-8} = 1.7 \times 10^{-8}$ g.
38. (a) $(4 \times 10^9)(2.5 \times 10^2) = 10 \times 10^{11} = 1 \times 10^{12}$ operations.
(b) $t = \frac{5 \times 10^{12}}{4 \times 10^9} = 1.25 \times 10^3 = 1.25 \times 10^3$ s.
39. $\frac{6 \times 10^{24}}{7.5 \times 10^{22}} = 0.8 \times 10^2 = 80$. Earth has approximately 80 times the Moon's mass.
40. (a) 3.6×10^{-7} .
(b) IB written mathematical notation requires $a \times 10^k$ form; the calculator's E notation is a machine display convention, not the required final notation.
41. $x = \frac{1.2 \times 10^{-2}}{4 \times 10^5} = 0.3 \times 10^{-7} = 3 \times 10^{-8}$.
42. (a) $L = \frac{1.8 \times 10^7}{6 \times 10^3} = 0.3 \times 10^4 = 3 \times 10^3$ m.
(b) $P = 2(3 \times 10^3 + 6 \times 10^3) = 18 \times 10^3 = 1.8 \times 10^4$ m.
43. (a) $650 \text{ nm} = 650 \times 10^{-9} \text{ m} = 6.5 \times 10^{-7} \text{ m}$.
(b) $(6.5 \times 10^{-7})(2 \times 10^5) = 13 \times 10^{-2} = 1.3 \times 10^{-1} \text{ m}$.
44. $\frac{1.26 \times 10^{12}}{3.5 \times 10^8} = 0.36 \times 10^4 = 3.6 \times 10^3$ euros per person.
45. $\frac{2 \times 10^5}{5 \times 10^{-8}} = 0.4 \times 10^{13} = 4 \times 10^{12}$ droplets.
46. $(3.2 \times 10^9)(8) = 25.6 \times 10^9 = 2.56 \times 10^{10}$ bits.
47. $(5 \times 10^n)(4 \times 10^3) = 20 \times 10^{n+3} = 2 \times 10^{n+4}$. Hence $n + 4 = 10$, so $n = 6$.
48. $x - y = 1.2 \times 10^6 - 0.3 \times 10^6 = 0.9 \times 10^6 = 9 \times 10^5$. Therefore $\frac{x - y}{x} = \frac{9 \times 10^5}{1.2 \times 10^6} = 7.5 \times 10^{-1} = 7.5 \times 10^{-1}$.
49. (a) $(3 \times 10^8)(2 \times 10^4) = 6 \times 10^{12} = 6 \times 10^{12}$ m.
(b) Round trip $= 2(6 \times 10^{12}) = 1.2 \times 10^{13}$ m.
50. (a) $\frac{2.4 \times 10^{-2}}{8 \times 10^{-6}} = 0.3 \times 10^4 = 3 \times 10^3$ components along one side.
(b) $(3 \times 10^3)^2 = 9 \times 10^6 = 9 \times 10^6$ components.