Physics — Unit 1.2: Scientific Notation

Mixed with Unit 1.1 (Unit Conversions) · Hard Practice Set

AUX — Free Physics Resources | auxlearning.com

> **Calculator rule for this set:** assume only a simple, non-scientific calculator is available (no EE / EXP / x10^n button). Any exponent work — multiplying, dividing, adding, or aligning powers of ten — must be done by hand. The calculator may only be used for basic +, –, ×, ÷ on the decimal (mantissa) part of a number.

PROBLEM 1 *Foundational — standard form → scientific notation*

The average distance from Earth to the Sun is 149,600,000 km. Express this distance in proper scientific notation (one nonzero digit before the decimal point).

PROBLEM 2 *Foundational — scientific notation → standard form*

A red blood cell has a diameter of about 7.5×10^{-6} m. Write this value in standard decimal form (no scientific notation, no rounding).

PROBLEM 3 *Notation arithmetic — multiplication*

Multiply $(3.2\times10^{5}) \times (4.0\times10^{-2})$. Multiply the decimal parts on your calculator, then combine the powers of ten by hand. Show the unrounded product before you simplify, then give your final answer in proper scientific notation.

PROBLEM 4 *Notation arithmetic — division*

Divide $(9.6\times10^{7}) \div (2.4\times10^{3})$ using the same rule: calculator for the decimal division only, powers of ten by hand. Give your final answer in proper scientific notation.

PROBLEM 5 *Notation arithmetic — addition (different exponents)*

Add $(5.3\times10^{4}) + (2.1\times10^{3})$. You cannot add these directly — first rewrite both numbers with the **same** power of ten by hand, showing that step, then add the decimal parts. Give the final sum in proper scientific notation.

PROBLEM 6 *Notation arithmetic — subtraction (different exponents)*

Subtract $(6.0\times10^{-3}) - (4.5\times10^{-4})$. Align the exponents by hand before subtracting. Give the final answer in proper scientific notation.

PROBLEM 7 *Mixed 1.1 + 1.2 — unit conversion before notation*

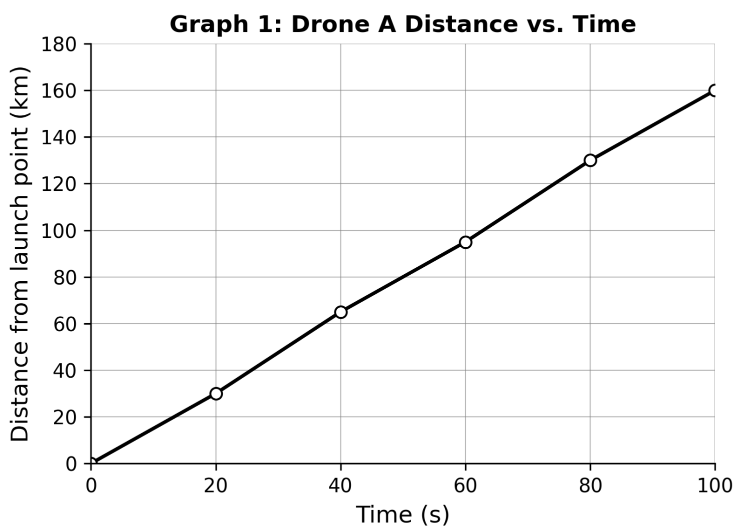
A bacterial colony spreads across a length of 0.000528 km. Convert this length to **centimeters**, then express your result in scientific notation.

PROBLEM 8 *Mixed 1.1 + 1.2 — TRAP: two-part answer format*

A capacitor stores a charge of 0.0000091 C (coulombs). A technician needs this value logged in **microcoulombs (μC)**, written in **scientific notation**. Convert the unit AND format the notation correctly — your final answer needs both parts right, not just one. ($1\ \mu C = 1\times10^{-6}$ C)

PROBLEM 9 *Graph reading + unit conversion + notation*

Graph 1 below shows a drone's distance from its launch point during a test flight. Using the graph, read the drone's distance at **t = 80 s**. Convert that distance to **meters** and express your final answer in scientific notation.



PROBLEM 10 *Table data — mixed units → scientific notation*

The table below lists the masses of four objects, each given in a **different** unit. Convert every mass to **kilograms**, express each in scientific notation, then list the four objects in order from lightest to heaviest.

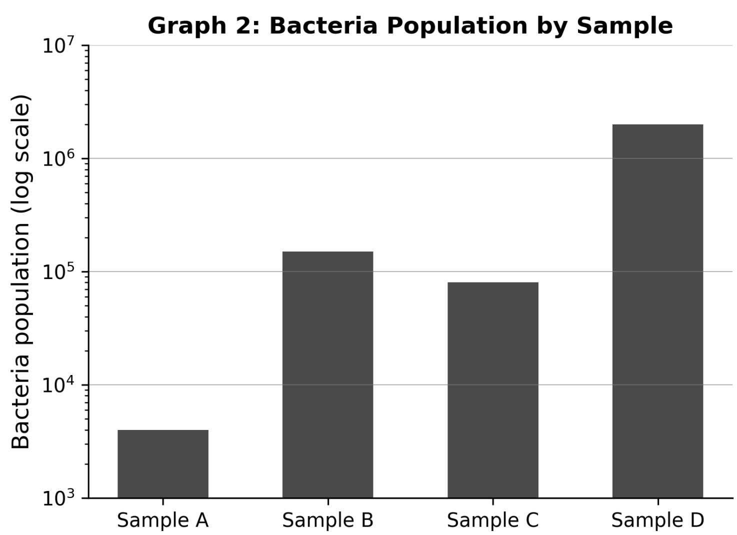
Object	Mass (as measured)
Dust mite	0.0000004 g
Grain of rice	28 mg
Apple	180 g
Adult cat	4.5 kg

PROBLEM 11 *Order of magnitude — basic comparison*

An atom has a diameter of about 1×10^{-10} m. A basketball has a diameter of about 2.4×10^{-1} m. How many orders of magnitude larger is the basketball's diameter than the atom's diameter? (Compare exponents — do not compute the full ratio.)

PROBLEM 12 *Graph reading — log scale + precise ratio*

Graph 2 below shows the population of four bacteria samples on a logarithmic scale. (a) From the graph alone, estimate the **order of magnitude** (nearest power of ten) of Sample A's population and Sample B's population. (b) The lab's precise instrument readings were Sample C = 8.0×10^{4} and Sample D = 2.0×10^{6} bacteria. Calculate *exactly* how many times greater Sample D's population is than Sample C's population.



PROBLEM 13 *Table data — TRAP: select the correct row*

The table below lists the average distance from the Sun to four planets, in kilometers. Identify the **third closest** planet to the Sun using the table — then convert **only that planet's** distance to meters and express it in scientific notation. (Distances are not listed in order.)

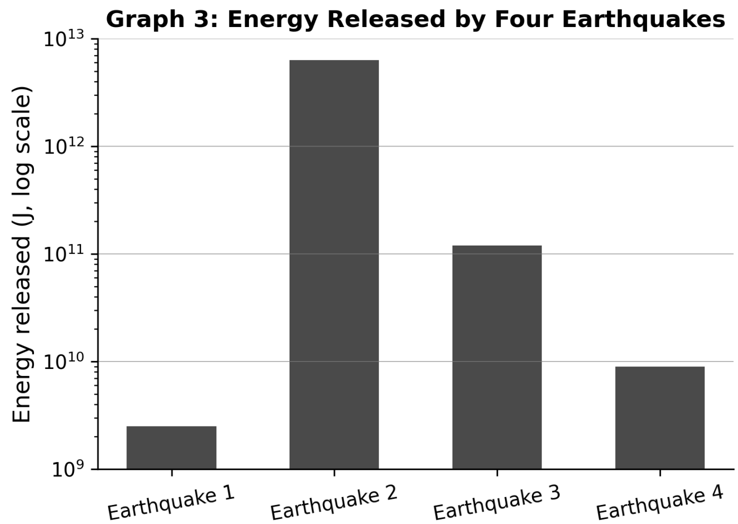
Planet	Average distance from Sun (km)
Mars	227,900,000 km
Mercury	57,900,000 km
Earth	149,600,000 km
Venus	108,200,000 km

PROBLEM 14 *Hardest tier — double conversion of a notation value*

A measuring instrument records a length of 3.4×10^4 cm. Convert this length to **kilometers** and express your final answer in scientific notation. Be careful — you are changing both the unit and the power of ten in the same problem.

PROBLEM 15 *Hardest tier — graph + ratio + unit conversion*

Graph 3 below shows the energy released by four earthquakes, plotted on a logarithmic scale, in joules (J). Precise readings: Earthquake 2 = 6.3×10^{12} J, Earthquake 4 = 9.0×10^9 J. (a) Calculate exactly how many times more energy Earthquake 2 released than Earthquake 4. (b) Convert Earthquake 4's energy to **kilojoules (kJ)** and express it in scientific notation.



PROBLEM 16 *Capstone — graph + table + conversion + order-of-magnitude trap*

Use Graph 1 again (the drone distance graph from Problem 9). A second drone, Drone B, travels a measured distance of 2.56×10^7 cm during the same test window.

(a) Determine Drone A's distance at **t = 100 s** from Graph 1, in kilometers.
(b) Convert Drone B's distance to kilometers.
(c) Find the positive difference between the two drones' distances. Convert that difference to **meters** and express it in scientific notation.
(d) State the **order of magnitude** (the correctly rounded nearest power of ten) of that difference. Order of magnitude is not automatically the exponent sitting in your part (c) answer — check whether the mantissa rounds up to the next power of ten.

Answer Key

Full worked solutions. Units are bolded in every final answer. Each problem lists the single most common mistake students make on that exact problem.

1 Standard form → scientific notation

149,600,000 km = $1.496{\times}10^8$ km — decimal moves 8 places left, so the exponent is +8.

Final answer: $1.496{\times}10^8$ km

Common error: Writing $1.496{\times}10^7$ by miscounting the decimal shift, or leaving an extra digit before the decimal point (e.g. $14.96{\times}10^7$, which is not proper scientific notation).

2 Scientific notation → standard form

$7.5{\times}10^{-6}$ m: the negative exponent means the decimal moves 6 places LEFT from 7.5, adding leading zeros.

0.0000075 m — count: 7,5 then 5 more zero-placeholders before the 7 to land 6 places back.

Final answer: 0.0000075 m

Common error: Miscounting zeros — writing 0.000075 (5 zeros) instead of 0.0000075 (6 zeros) before the 7.

3 Multiplication

3.2 × 4.0 = 12.8 (calculator step). Exponents add by hand: $10^5 \times 10^{-2} = 10^3$.

Unrounded result: $12.8{\times}10^3$. This is NOT proper notation (12.8 has two digits before the decimal), so shift one place: $1.28{\times}10^4$.

Final answer: $1.28{\times}10^4$

Common error: Stopping at $12.8{\times}10^3$ without renormalizing to one digit before the decimal point.

4 Division

9.6 ÷ 2.4 = 4.0 (calculator step). Exponents subtract by hand: $10^7 \div 10^3 = 10^4$.

Final answer: $4.0{\times}10^4$

Common error: Adding the exponents instead of subtracting them when dividing.

5 Addition with different exponents

Rewrite $2.1{\times}10^3$ with exponent 4: $2.1{\times}10^3 = 0.21{\times}10^4$.

Now add decimal parts: 5.3 + 0.21 = 5.51.

Final answer: $5.51{\times}10^4$

Common error: Adding 5.3 + 2.1 = 7.4 directly without first matching the exponents — the calculator will not catch this because it never sees the powers of ten.

6 Subtraction with different exponents

Rewrite 4.5×10^{-4} with exponent -3: $4.5\times10^{-4} = 0.45\times10^{-3}$.

Subtract decimal parts: 6.0 – 0.45 = 5.55.

Final answer: 5.55×10^{-3}

Common error: Subtracting 6.0 – 4.5 = 1.5 directly and slapping on one of the original exponents without aligning them first.

7 Unit conversion → notation

0.000528 km to cm: 1 km = 100,000 cm, so 0.000528 × 100,000 = 52.8 cm.

52.8 cm in scientific notation: 5.28×10^{1} cm.

Final answer: 5.28×10^{1} cm

Common error: Converting km to cm using the wrong factor (confusing it with the km-to-m factor of 1,000 instead of the km-to-cm factor of 100,000).

8 TRAP — unit + notation together

0.0000091 C = 9.1×10^{-6} C.

Since 1 μC = 1×10^{-6} C, the exponent of -6 converts directly: 9.1×10^{-6} C = 9.1 μC.

9.1 μC must still be reported in scientific notation form: 9.1×10^{0} μC.

Final answer: 9.1×10^{0} μC

Common error: Giving only one of the two required pieces — either leaving the answer as 9.1×10^{-6} C (correct notation, wrong unit) or writing plain '9.1 μC' without the required $\times10^{0}$ scientific notation form.

9 Graph reading + conversion

From Graph 1, at t = 80 s the distance reads 130 km.

Convert to meters: 130 km × 1,000 = 130,000 m.

In scientific notation: 1.3×10^{5} m.

Final answer: 1.3×10^{5} m

Common error: Reading the graph correctly (130 km) but reporting the final answer still in km, skipping the required unit conversion to meters.

10 Mixed-unit table → kg → ordering

Dust mite: 0.0000004 g = 4×10^{-7} g = 4×10^{-10} kg.

Grain of rice: 28 mg = 0.028 g = 2.8×10^{-5} kg.

Apple: 180 g = 0.18 kg = 1.8×10^{-1} kg.

Adult cat: 4.5 kg = 4.5×10^{0} kg.

Order, lightest to heaviest: dust mite (4×10^{-10} kg) < grain of rice (2.8×10^{-5} kg) < apple (1.8×10^{-1} kg) < cat (4.5×10^{0} kg)

Common error: Converting each mass to scientific notation correctly but then ordering by the size of the mantissa instead of the actual value (e.g. ranking 4.5×10^{0} as smaller than 2.8×10^{-5} because '2.8 < 4.5').

11 Order of magnitude comparison

Compare exponents only: basketball is 10^{-1}, atom is 10^{-10}.

Difference in exponents: -1 – (-10) = 9.

Final answer: 9 orders of magnitude

Common error: Computing the full ratio ($2.4 \times 10^{-1} \div 1 \times 10^{-10} = 2.4 \times 10^{9}$) and then answering '$2.4 \times 10^{9}$' instead of just the order of magnitude, which is the exponent, 9.

12 Log-scale graph reading + precise ratio

(a) From the gridlines, Sample A's bar sits at the 10^{3} order of magnitude line; Sample B's bar sits between 10^{5} and 10^{6}, closer to 10^{5}.

(b) $2.0 \times 10^{6} \div 8.0 \times 10^{4}$: decimal part 2.0 ÷ 8.0 = 0.25; exponents $10^{6} \div 10^{4} = 10^{2}$.

0.25×10^{2} renormalizes to 2.5×10^{1} = 25.

Final answer: Sample D is 25 times greater than Sample C

Common error: Subtracting the populations ($2.0 \times 10^{6} - 8.0 \times 10^{4}$) instead of dividing them when the question asks 'how many times greater,' which is always a ratio, not a difference.

13 TRAP — correct row selection + conversion

Ordering distances: Mercury (57.9 million km) < Venus (108.2 million km) < Earth (149.6 million km) < Mars (227.9 million km).

Third closest to the Sun is Earth, at 149,600,000 km.

Convert to meters: 149,600,000 km × 1,000 = 149,600,000,000 m.

In scientific notation: 1.496×10^{11} m.

Final answer: 1.496×10^{11} m (Earth)

Common error: Grabbing Mars's distance because it is listed first in the table, instead of ranking all four distances to find the actual third-closest planet.

14 Double conversion of a notation value

3.4×10^4 cm to km: 1 km = 100,000 cm = 10^5 cm, so divide by 10^5.
$3.4\times10^4 \div 10^5 = 3.4\times10^{-1}$.

Final answer: 3.4×10^{-1} km

Common error: Converting cm to km using the cm-to-m factor (10^2) instead of the full cm-to-km factor (10^5), landing on 3.4×10^2 km instead of 3.4×10^{-1} km.

15 Graph + ratio + unit conversion

(a) $6.3\times10^{12} \div 9.0\times10^9$: $6.3 \div 9.0 = 0.7$; $10^{12} \div 10^9 = 10^3$.
0.7×10^3 renormalizes to 7.0×10^2 = 700 times.
(b) 9.0×10^9 J to kJ: divide by 1,000 (10^3): $9.0\times10^9 \div 10^3 = 9.0\times10^6$ kJ.

Final answers: (a) 700 times more energy (b) 9.0×10^6 kJ

Common error: In part (b), converting J to kJ by ADDING 3 to the exponent instead of subtracting, since dividing by 1,000 should make the number smaller, not larger.

16 Capstone — graph + conversion + order-of-magnitude rounding trap

(a) From Graph 1, at t = 100 s, Drone A's distance is 160 km.
(b) Drone B: 2.56×10^7 cm to km — divide by 10^5: $2.56\times10^7 \div 10^5 = 2.56\times10^2$ km = 256 km.
(c) Difference: 256 km – 160 km = 96 km = 9.6×10^1 km. Convert to meters: $9.6\times10^1 \times 10^3 = 9.6\times10^4$ m.
(d) Order of magnitude rounds the mantissa to the NEAREST power of ten. Since 9.6 is closer to 10 than to 1, it rounds UP: 9.6×10^4 m rounds to 1×10^5 m.

Final answers: (c) 9.6×10^4 m (d) order of magnitude is 10^5

Common error: Reading the exponent straight off the part (c) answer and reporting the order of magnitude as 10^4 — skipping the rounding check on the mantissa (9.6 rounds up to 10, which bumps the power of ten up by one).