Course compass

Question directrice : How do you read a unit, understand what it measures and decide whether a result makes sense?

Markers: 📏 MEASURED · 📐 CONVENTION · 🧮 CALCULATED · 🎓 TEACHING ASSUMPTION · ⚠️ APPROXIMATION

- understand the concept
- do a simple calculation
- explain every symbol
- check a result

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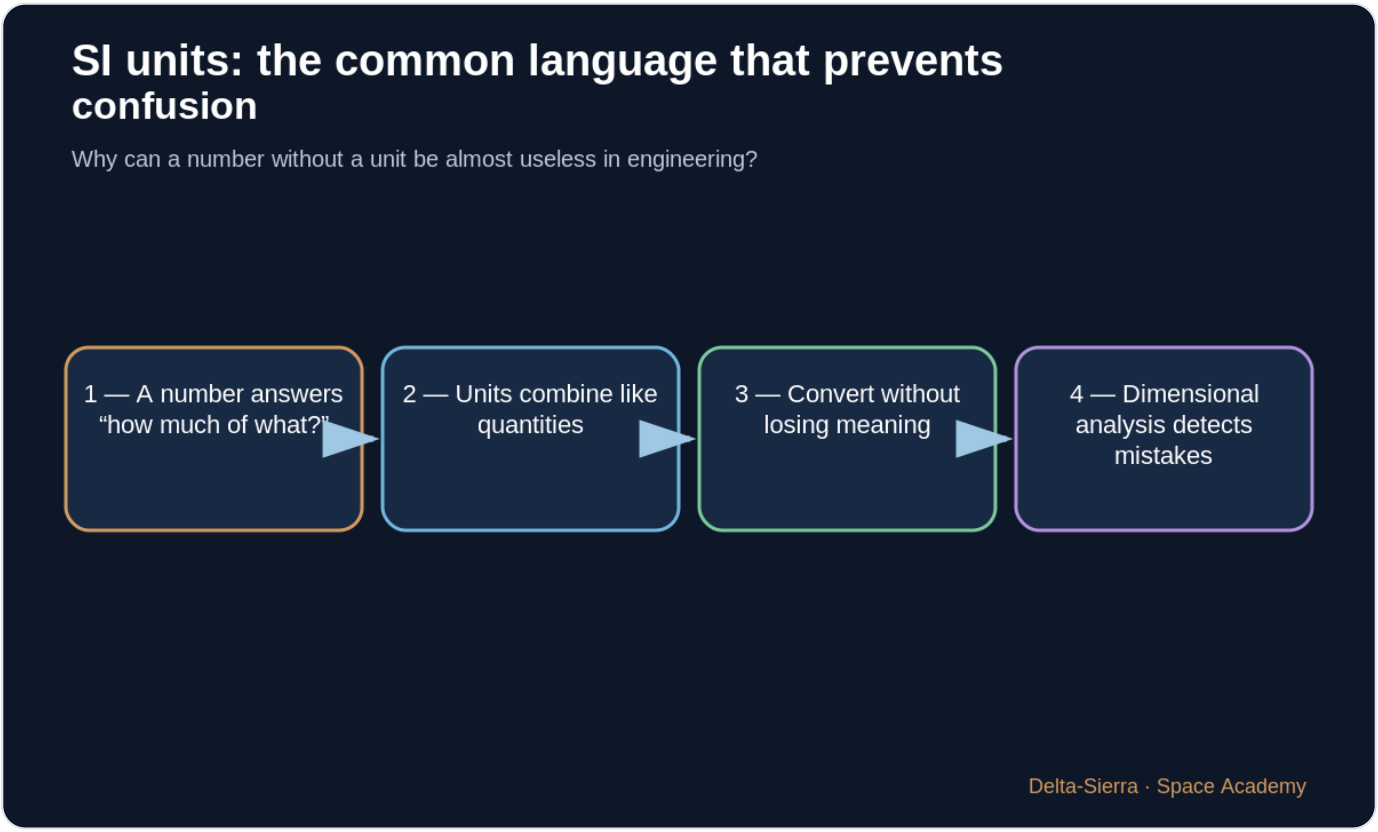
1 — A number always answers “how much of what?”

A number by itself can be almost useless in engineering. “500” does not tell us whether it means 500 grams, kilograms, seconds, watts or square metres.

A **quantity** combines a value with what is being measured. A **unit** provides the common reference used to express that quantity.

Simple example

“The tank contains 120” is incomplete. “The tank contains **120 kg of propellant**” already tells us what the number means.



A value and its unit must stay together.

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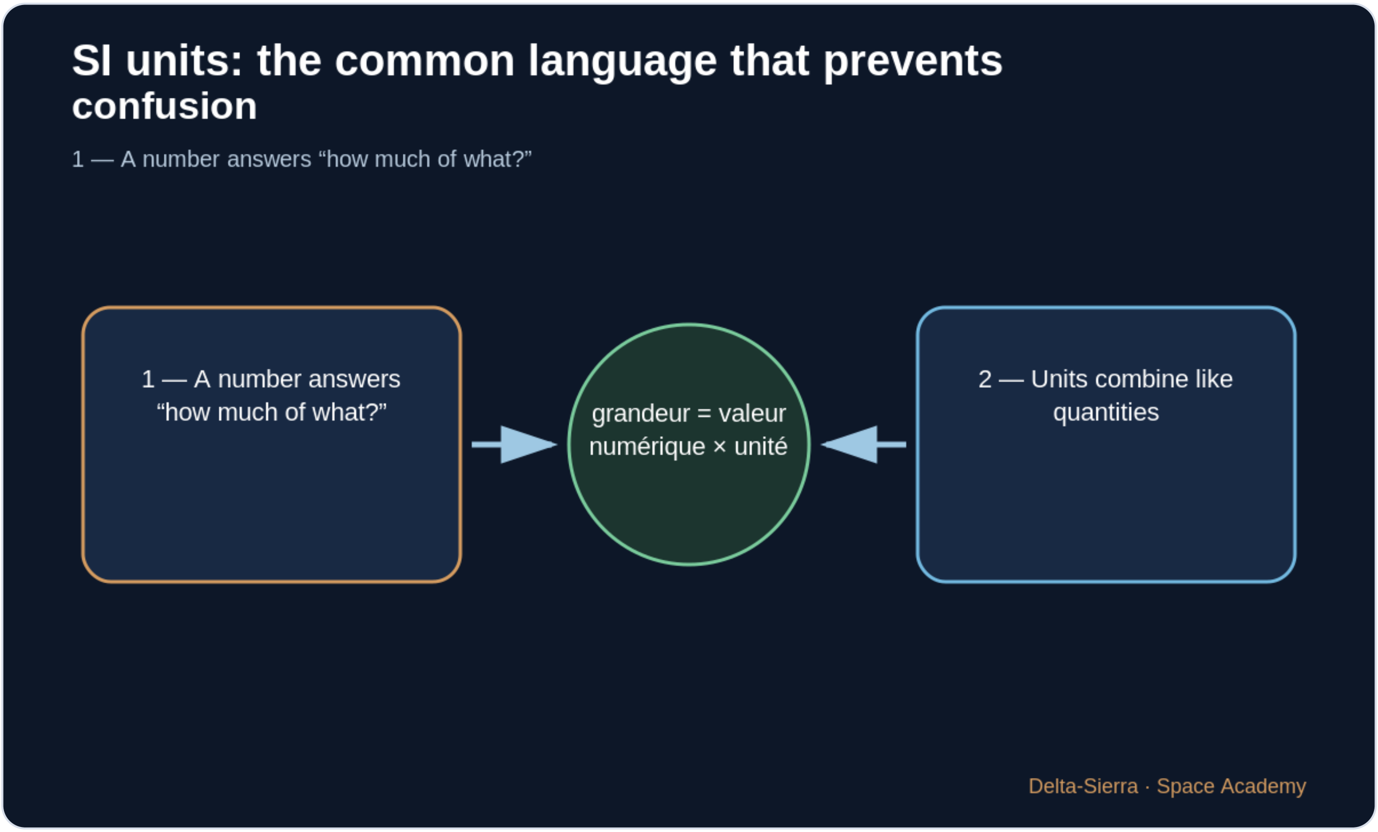
2 — Read symbols aloud

- **kg**: kilogram, unit of mass;
- **s**: second, unit of time;
- **m**: metre, unit of length;
- **m²**: square metre, unit of area;
- **m/s**: metres per second;
- **m/s²**: metres per second squared, unit of acceleration;
- **N**: newton, unit of force;
- **W**: watt, unit of power.

The International System of Units, or **SI**, organizes base and derived units. NIST notes, for example, that area is expressed in m^2, speed in m/s and acceleration in m/s^2.



Reading “per” and “squared” already reveals part of the physical meaning.

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3 — kg/s : how much propellant per second?

kg/s is read **“kilograms per second”**. It answers: how many kilograms pass or are consumed during one second?

Space example — 120 kg of propellant in 4 seconds

Imagine a rocket engine consuming **120 kg of propellant** over **4 seconds**.

Propellant is the material consumed by the engine to produce thrust; depending on the engine, it may include a fuel and an oxidizer.

To find the average for one second, divide the total mass by the total time: $120 \div 4 = 30$.

Result: **30 kg/s**.

After 1 s: about 30 kg; after 2 s: 60 kg; after 3 s: 90 kg; after 4 s: 120 kg.

The technical term is mass flow rate: mass passing per unit time.

Calculator

Type **120 ÷ 4 =**. The result 30 carries the unit kg/s because a mass in kilograms was divided by a time in seconds.

4 — `N/kg` : force per kilogram

N/kg is read **“newtons per kilogram”**.

A **newton**, symbol N, is the SI unit of force. At beginner level, a force is a push or pull that can change an object’s motion.

Mars surface gravity is about **3.71 m/s²**. The same gravitational field strength may also be expressed numerically as about **3.71 N/kg**: each kilogram experiences about 3.71 newtons of weight near the surface.

Example — A 10 kg tool on Mars

Tool mass: 10 kg. Teaching value for gravitational field: 3.71 N/kg.

$10 \times 3.71 = 37.1$.

Result: about **37.1 N** of weight.

Mass versus weight: the tool remains 10 kg; its weight is a force that depends on gravity and is measured in newtons.

5 — `W/m²` : power per area

W/m² is read **“watts per square metre”**.

The **watt**, W, is the SI unit of power. A **square metre**, m², is the area of a square one metre on each side.

Example — A 2 m² solar panel

Suppose, in a deliberately simplified teaching model, that a 2 m² panel receives a uniform **500 W/m²**.

Each square metre receives 500 W. Two square metres receive $500 \times 2 = 1{,}000$.

Result: **1,000 W** incident on the 2 m² panel in this simplified model.

This is not automatically the electrical output. Efficiency, angle, temperature and other losses would still matter.

6 — Convert without losing meaning

2.5 km to metres

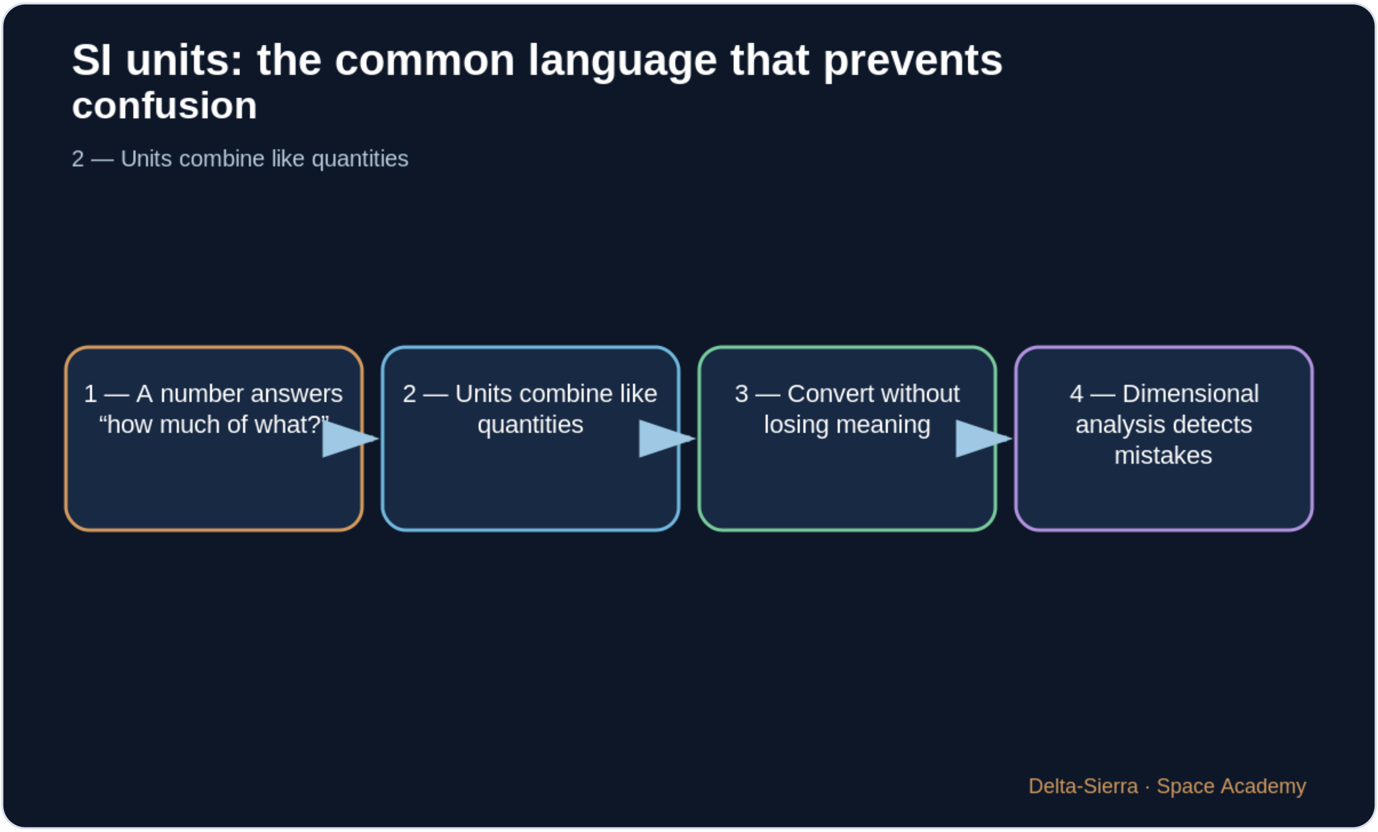
1 km = 1,000 m, so 2.5 km = 2,500 m.

72 km/h to m/s

72 km = 72,000 m and 1 h = 3,600 s. Therefore 72,000 ÷ 3,600 = **20 m/s**.

Area

0.50 m × 0.40 m = 0.20 m². Units multiply too: m × m = m².



A correct conversion preserves the same physical quantity.

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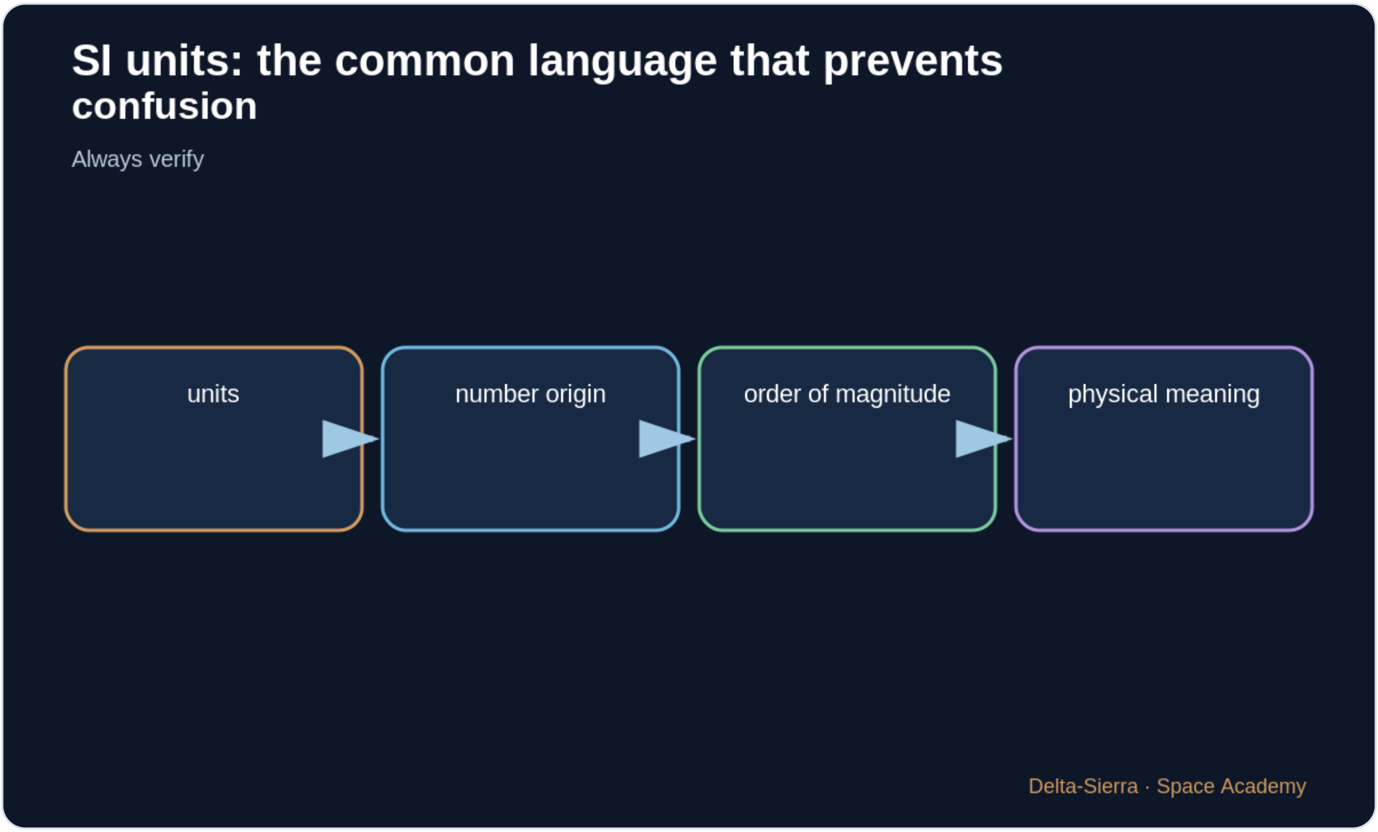
7 — Dimensional analysis detects errors

Units act like a second calculation line. If a formula claims to produce a speed but ends in kilograms, something is wrong.

Mass divided by time produces kg/s. Power divided by area produces W/m². Force divided by mass produces N/kg.



Units can reveal an error before the number itself is inspected.

Three complete examples: one unit, one question, one result

Each unit answers a different physical question.

Example A — Mass flow

90 kg in 3 s: 90 ÷ 3 = 30 kg/s.

Example B — Weight on Mars

5 kg × 3.71 N/kg = about 18.55 N.

Example C — Power per area

3 m² receiving 400 W/m² gives 1,200 W incident in a uniform simplified model.

Common traps and checks

- Writing a number without its unit.
- Confusing mass in kg with force in N.
- Reading m² without understanding that it means square metres.
- Confusing 120 kg over four seconds with 120 kg/s.
- Multiplying quantities without checking what happens to their units.

Control question: **does the result answer the original question with the correct unit?**

Exercises and solutions

Exercise 1 — Read the unit

How do you read kg/s, N/kg and W/m^2?

Solution: kilograms per second; newtons per kilogram; watts per square metre.

Exercise 2 — Flow rate

An engine consumes 200 kg in 5 s. What is the average mass flow rate?

Solution: $200 \div 5 = 40$ kg/s.

Exercise 3 — Solar panel

A 1.5 m^2 panel receives a uniform 600 W/m^2. What incident power does it receive in this model?

Solution: $1.5 \times 600 = 900$ W.

Primary and teaching sources

- NIST — SI Units
- NIST — SI Units: Area
- NASA — Planet Compare: surface gravity
- NASA Science — Mars Facts