AM-02.03 · SPACE ACADEMY

AM-02.03 — Mass, weight, and gravity: why 80 kg does not become 13 kg on the Moon

What is the difference between an object’s mass and the gravitational force acting on it?

Course compass

Goal: understand every word, symbol, unit and operation before using the formula.

Method: concrete situation → vocabulary → step-by-step calculation → three examples → check.

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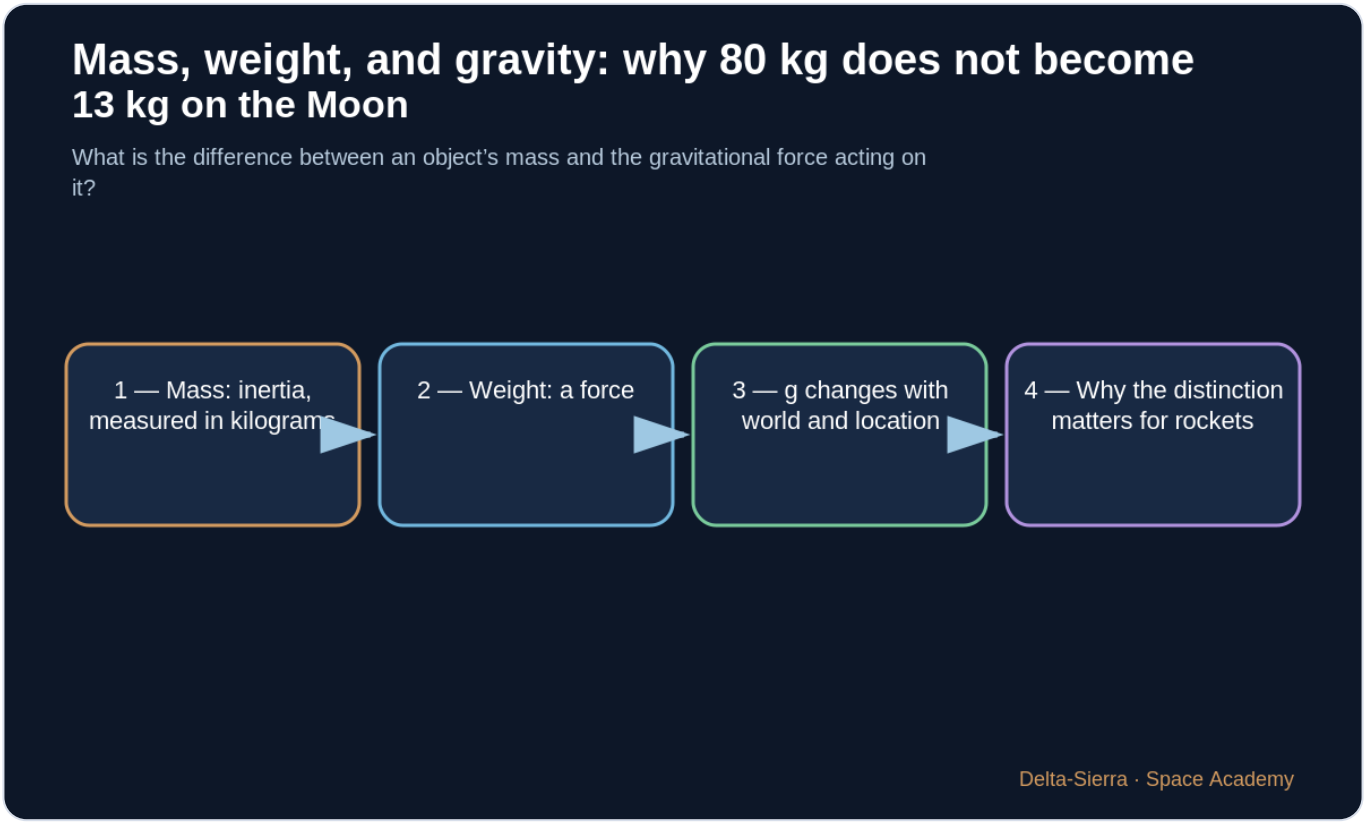
1 — A 10 kg crate does not lose mass on Mars

The crate still has a mass of **10 kg** on Earth or Mars. Its **weight** changes because weight is a gravitational force.

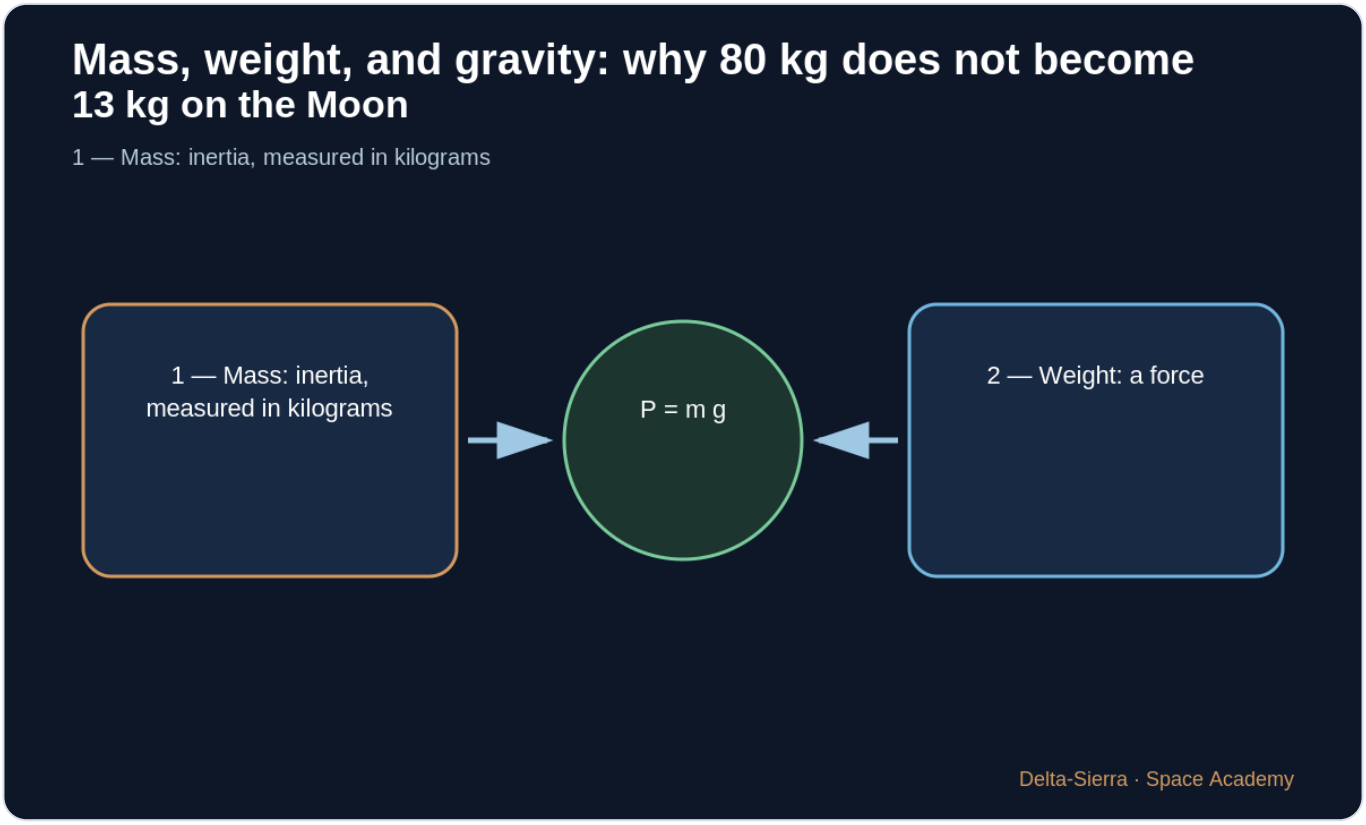


Mass stays the same; weight depends on local gravity.

2 — Kilograms and newtons are different units

- **kg**: kilograms, mass;
- **N**: newtons, force;
- **N/kg**: newtons per kilogram, gravitational field strength.

Near the Martian surface, beginner calculations commonly use **g ≈ 3.71 N/kg**.



Each kilogram experiences about 3.71 N of weight near the Martian surface.

3 — Weight formula: W = m × g

$$W = m \times g$$

Read it: “W equals m times g”. Here W means weight, m mass, g gravitational field strength.

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W = 10 × 3.71 = 37.1 N
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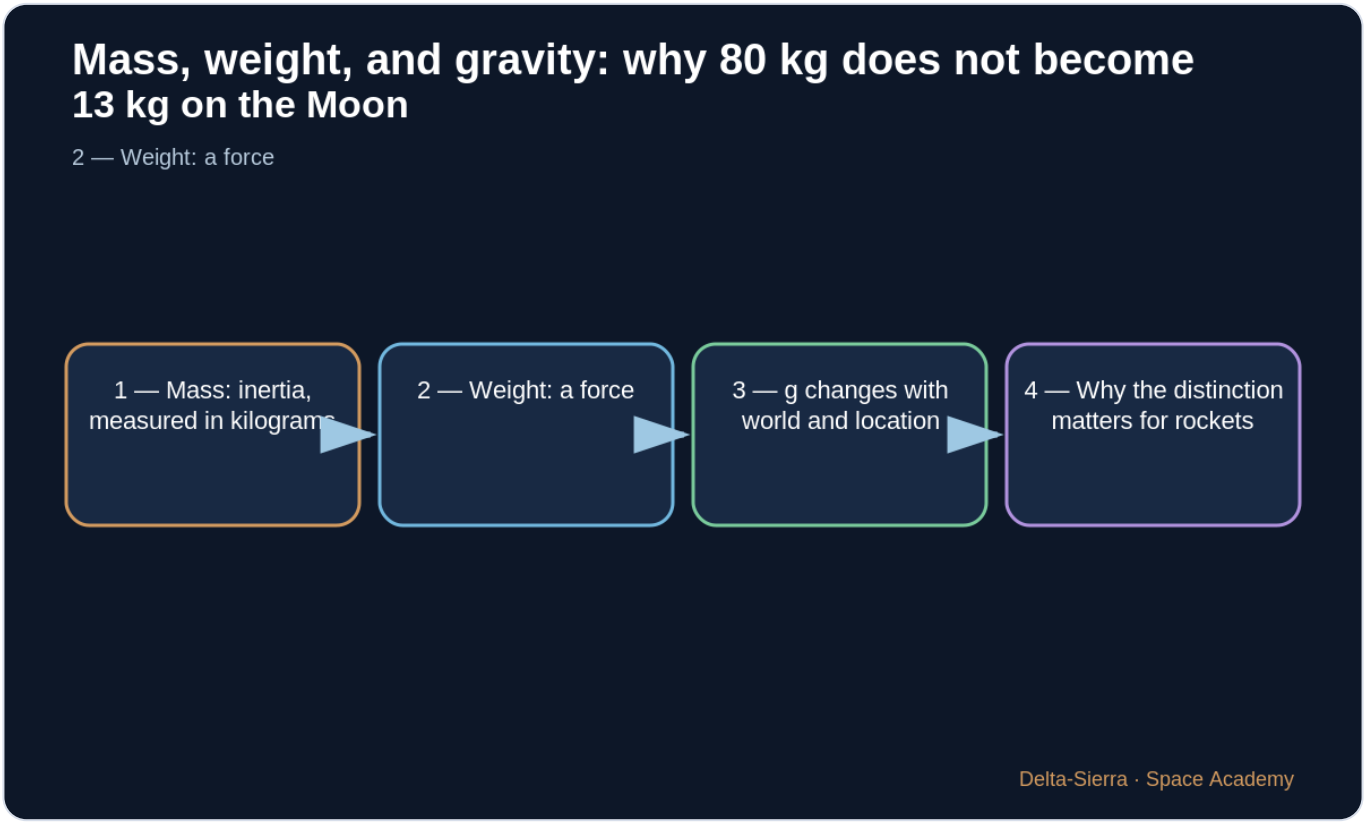
Why multiply? Each of the 10 kilograms experiences about 3.71 N.



Mass × local gravity = weight.

4 — Earth and Mars comparison

For a mass of 80 kg:

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Mars: W ≈ 80 × 3.71 = 296.8 N
Earth: W ≈ 80 × 9.81 = 784.8 N
```

The mass stays 80 kg.

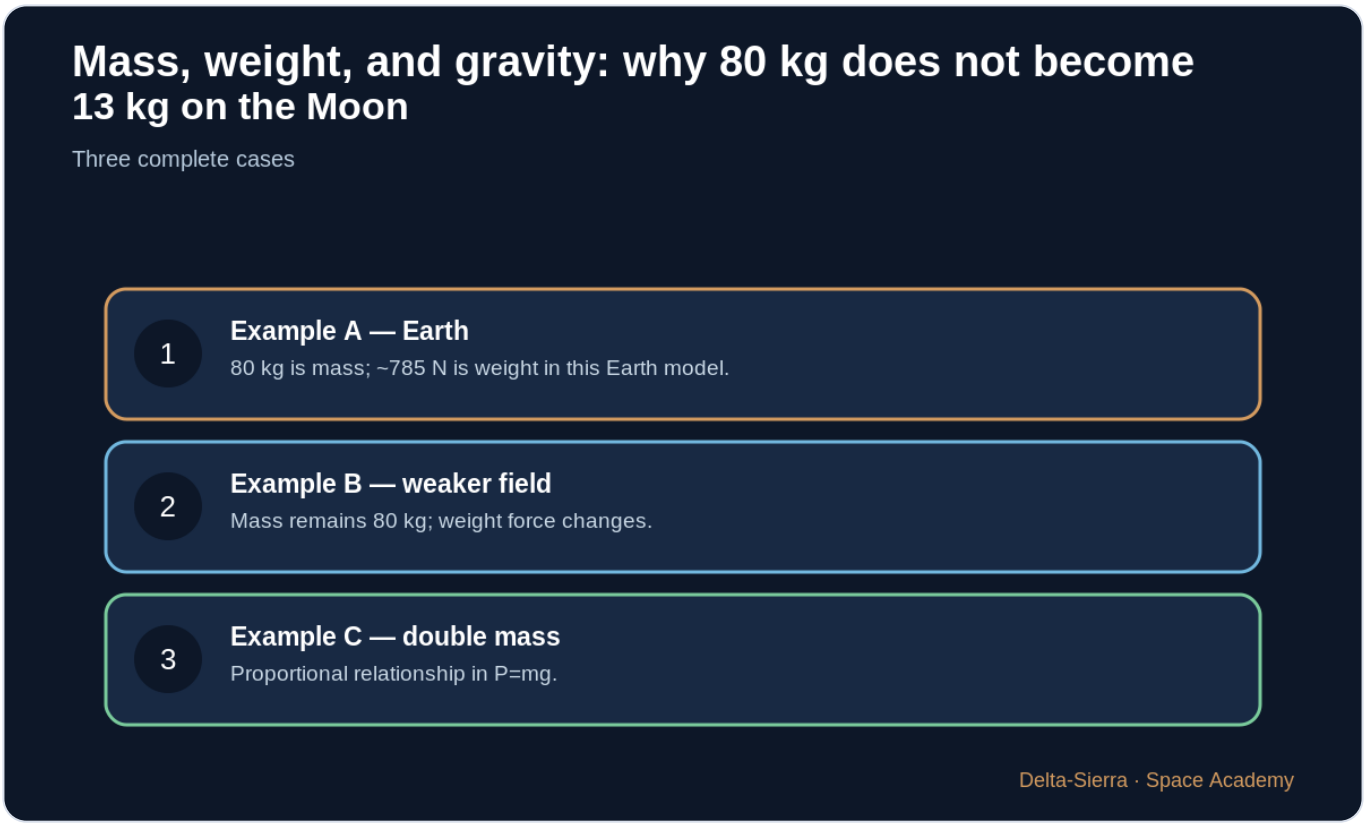
> **Important:** lower weight does not remove inertia. A massive crate is still hard to accelerate and stop.

5 — What is a newton?

$$1\ \text{N} = 1\ \text{kg} \times 1\ \text{m/s}^2$$

One newton gives a 1 kg mass an acceleration of 1 m/s² if it is the net force along that direction.

6 — Three examples



Tool, suited astronaut and cargo examples.

Example A — 10 kg tool

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W Mars = 37.1 N
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Example B — 120 kg astronaut plus suit

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W Mars = 120 × 3.71 = 445.2 N
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Example C — Find mass from weight

Weight = 185.5 N.

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m = W ÷ g = 185.5 ÷ 3.71 = 50 kg
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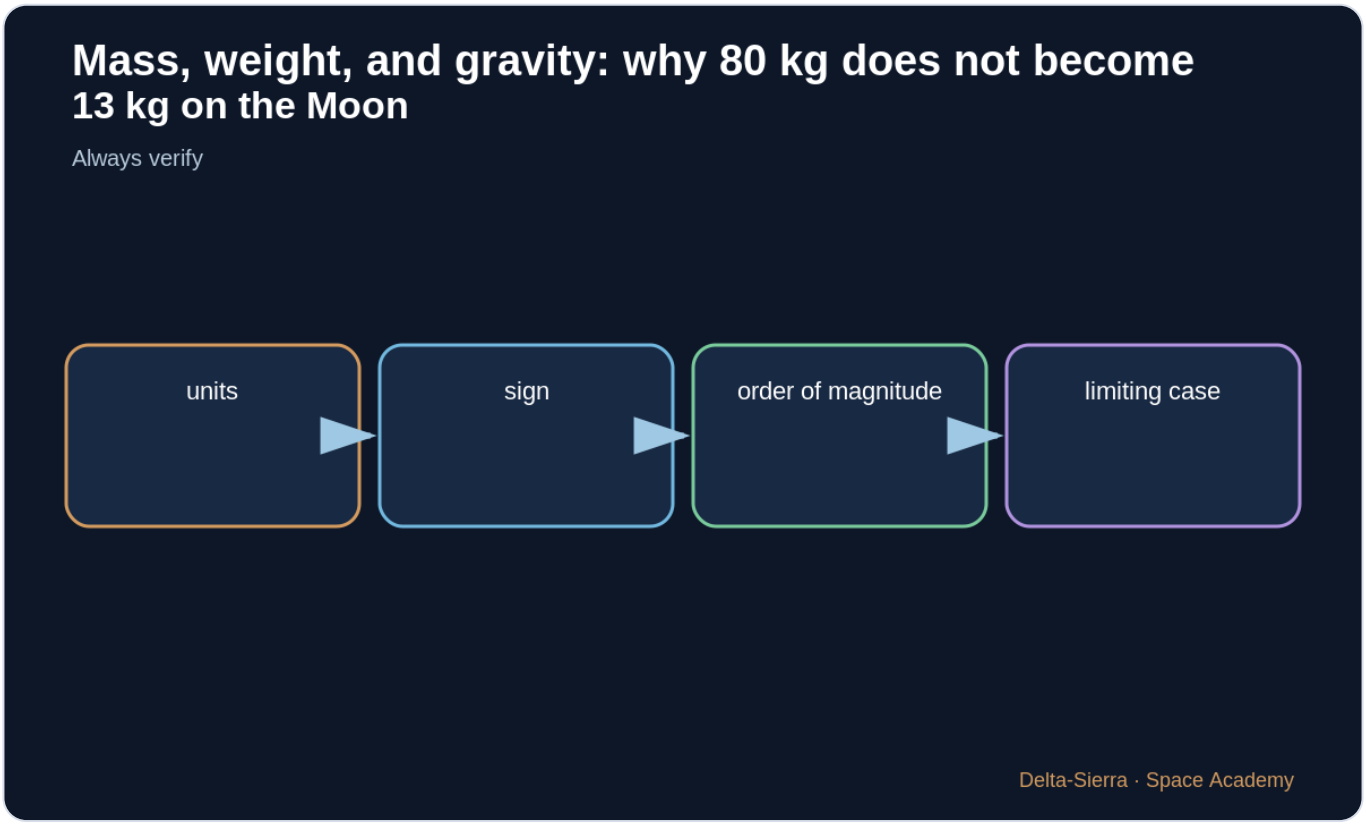
7 — g is not universal

It varies with the celestial body and position. Use a value appropriate to the model and required precision.



Final check: never mix kilograms and newtons.

Beginner checkpoint — which quantity is the number describing?

If the value is in kilograms, it is a mass. If it is in newtons, it is a force and may be a weight. If it is in newtons per kilogram, it describes gravitational field strength. Keeping the unit attached to every number prevents the common statement that an object “becomes 38% of its kilograms” on Mars.

For a 100 kg cargo item, the mass remains 100 kg. Near the Martian surface, its weight is about 371 N using g = 3.71 N/kg. The lower weight helps with lifting and support loads, but the 100 kg mass still determines inertia. That distinction matters for vehicle braking, robotic arms, cranes and collision safety.

8 — Corrected exercises

Exercise 1

25 kg battery on Mars?

25 × 3.71 = 92.75 N.

Exercise 2

Does 100 kg become 38 kg on Mars?

No. Mass remains 100 kg; weight is about 371 N.

Primary and educational sources

- NASA Glenn - Rocket Weight
- NASA Science - Basics of Space Flight: Gravity & Mechanics
- NIST - International System of Units (SI)