

Exercise walk-through

Newton's First Law ■ 2.4

eXercise

You must be able to

- state **Newton's first law** 牛顿第一定律: an object's velocity stays constant unless a net external force acts
- define **inertia** 惯性 as the resistance to a change in motion, measured by **mass** 质量
- state the condition for **translational equilibrium** 平动平衡 (net force zero)
- apply the first law to objects at rest or moving at constant velocity

Method — Equilibrium means balanced forces

An object is in **translational equilibrium** when $\sum \vec{F} = 0$. This includes both **at rest** and **constant velocity** — “no net force” does **not** mean “no motion”.

Method — Inertia and mass

More mass $\rightarrow$ more inertia $\rightarrow$ harder to speed up, slow down, or turn. A loaded truck is harder to stop than a bicycle at the same speed.

Method — Balancing forces

A crate slides at constant velocity, so the forces balance: if friction is 30 N backward, the applied pull must be 30 N forward.

Practice 2.1 ■ 1 mark

A car moves along a straight road at a **constant** 20 m s^{-1} . State the net force on it.

Solution 2.1

Worked steps

zero — constant velocity means the forces are balanced **B1**.

Practice 2.2 ■ 2 marks

A box sits still on a floor. Friction can act up to 12 N. A push of 7.0 N is applied. State the friction force and whether the box moves.

Solution 2.2

Method: Balancing forces

Worked steps

friction = 7.0 N (it matches the push up to its maximum) **B1**; the box does not move, since $7.0 < 12$ N **B1**.

Practice 2.3 ■ 2 marks

Explain, using inertia, why passengers lurch forward when a bus brakes suddenly.

Solution 2.3

Worked steps

The passengers have inertia, so they tend to keep moving forward at the original speed **B1** while the bus slows beneath them **B1**.

Exam-style 3.1 ■ 1 mark

An object is in translational equilibrium. Its velocity must be

A zero

B constant (possibly zero)

C increasing

D decreasing

Solution 3.1

Method: Equilibrium means balanced forces

A zero

B constant (possibly zero)



C increasing

D decreasing

Worked steps

B.

Exam-style 3.2 ■ 1 mark

Which object has the greatest inertia?

A a 0.5 kg ball

B a 2 kg book

C a 50 kg crate

D a 1 kg brick

Solution 3.2

A a 0.5 kg ball

B a 2 kg book

C a 50 kg crate



D a 1 kg brick

Worked steps

C.

Exam-style 3.3 ■ 1 mark

A 500 N lamp hangs at rest from a single cable.

- (a) State the tension in the cable.
- (b) State the net force on the lamp, and justify with the first law.

Solution 3.3

Method: Equilibrium means balanced forces

Worked steps

(a) 500 N **B1**. (b) zero **B1** — at rest is equilibrium, so the net force must be zero by the first law **B1**.