Exercise walk-through

Newton's Second Law ▪ 2.5

eXercise

You must be able to

- apply **Newton's second law 牛顿第二定律**: $\vec{F}_{net} = m\vec{a}$
- find acceleration from a net force, or net force from an acceleration
- solve for one unknown among force, mass, and acceleration
- combine with free-body diagrams to find the net force first

Method — The core equation

$$\vec{F}_{net} = m\vec{a}.$$

A 4 kg block with a net force of 12 N accelerates at

$$a = \frac{F_{net}}{m} = \frac{12}{4} = 3 \text{ m s}^{-2}.$$

Method — Find the force

Rearrange: $F_{net} = ma$. A 2 kg ball accelerating at 5 m s^{-2} needs $F_{net} = 2 \times 5 = 10$ N.

Method — Use the net force

First combine the forces, then apply $F_{net} = ma$. A 3 kg box pulled by 20 N against 8 N of friction: $F_{net} = 12$ N, so $a = 12/3 = 4$ m s^{-2}.

Practice 2.1 ▪ 2 marks

A net force of 18 N acts on a 6 kg mass. Find the acceleration.

Solution 2.1

Worked steps

$a = F/m = 18/6 = 3\ \text{m s}^{-2}$ M1 A1.

Practice 2.2 ▪ 2 marks

A 3 kg object accelerates at 4 m s^{-2}. Find the net force.

Solution 2.2

Method: The core equation

Worked steps

$F = ma = 3 \times 4 = 12$ N M1 A1.

Practice 2.3 ▪ 2 marks

A 10 N net force gives an acceleration of 2 m s^{-2}. Find the mass.

Solution 2.3

Worked steps

$m = F/a = 10/2 = 5$ kg (M1)(A1).

Practice 2.4 ▪ 2 marks

A 5 kg crate is pushed by 25 N against 10 N friction. Find the acceleration.

Solution 2.4

Method: Use the net force

Worked steps

$F_{net} = 25 - 10 = 15$ N; $a = 15/5 = 3$ m s^{-2} M1 A1.

Exam-style 3.1 ▪ 1 mark

For a fixed net force, doubling the mass

A doubles the acceleration

B halves the acceleration

C leaves the acceleration unchanged

D quadruples the acceleration

Solution 3.1

A doubles the acceleration

B halves the acceleration ✓

C leaves the acceleration unchanged

D quadruples the acceleration

Worked steps

B — $a = F/m$, so doubling m halves a.

Exam-style 3.2 ▪ 1 mark

A 2 kg ball has a net force of 6 N. Its acceleration is

A $12\ \text{m s}^{-2}$

B $3\ \text{m s}^{-2}$

C $8\ \text{m s}^{-2}$

D $0.33\ \text{m s}^{-2}$

Solution 3.2

Method: Find the force

A $12\ \text{m s}^{-2}$

B $3\ \text{m s}^{-2}$ ✓

C $8\ \text{m s}^{-2}$

D $0.33\ \text{m s}^{-2}$

Worked steps

B — $a = 6/2 = 3\ \text{m s}^{-2}$.

Exam-style 3.3 ▪ 2 marks

A 1200 kg car speeds up at 2.5 m s^{-2}.
(a) Find the net driving force.
(b) State what happens to the acceleration if the same force acts on a heavier car.

Solution 3.3

Worked steps

(a) $F = ma = 1200 \times 2.5 = 3000$ N **M1** **A1**. (b) It decreases (more mass, less acceleration for the same force) **B1**.

Exam-style 3.4 ▪ 1 mark

A 2 kg block on a frictionless surface is pulled by two horizontal forces: 12 N right and 4 N left.

(a) Find the net force.

(b) Find the acceleration.

Solution 3.4

Method: Use the net force

Worked steps

(a) $12 - 4 = 8$ N **B1**. (b) $a = 8/2 = 4$ m s^{-2} **M1** **A1**.