Exercise walk-through

Newton's Second Law ▪ 2.5

eXercise

You must be able to

- state **Newton's second law 牛顿第二定律**, $\vec{a} = \dfrac{\sum \vec{F}}{m}$
- explain that acceleration is **proportional** to net force and **inversely proportional** to mass
- resolve forces into perpendicular **components 分量** on an inclined surface
- apply the second law to connected objects joined by a string

Method — Applying $F = ma$

A net force of 12 N on a 3.0 kg block gives $a = \dfrac{12}{3.0} = 4.0$ m s^{-2} in the direction of the net force.

Method — On an incline

Resolve weight along and perpendicular to the slope. On a frictionless incline of angle θ, the acceleration down the slope is $a = g\sin\theta$.

Method — Connected masses

For masses joined by a string, apply $F = ma$ to the **whole system** to find a, then to **one mass** to find the tension. A 2.0 kg and a 3.0 kg block pulled by 10 N: $a = \dfrac{10}{5.0} = 2.0$ m s^{-2}.

Practice 2.1 ▪ 1 mark

A net force of 20 N acts on a 4.0 kg trolley. Find its acceleration.

Solution 2.1

Method: Applying $F = ma$

Worked steps

$a = \dfrac{20}{4.0} = 5.0 \text{ m s}^{-2}$ B1.

Practice 2.2 ▪ 1 mark

A 1500 kg car accelerates at 2.0 m s^{-2}. Find the net force on it.

Solution 2.2

Method: Applying $F = ma$

Worked steps

$F = ma = 1500 \times 2.0 = 3000$ N B1.

Practice 2.3 ▪ 2 marks

A block slides down a frictionless ramp at 30° (take $g = 10$ m s^{-2}). Find its acceleration along the ramp.

Solution 2.3

Method: On an incline

Worked steps

$a = g\sin 30^\circ = 10 \times 0.5 = 5.0$ m s^{-2} M1 A1.

Practice 2.4 ▪ 1 mark

State how the acceleration changes if the net force doubles while the mass stays the same.

Solution 2.4

Worked steps

it also doubles (acceleration is proportional to net force) B1.

Exam-style 3.1 ▪ 1 mark

If the net force on an object doubles and its mass halves, the acceleration becomes

A unchanged

B twice as large

C four times as large

D half as large

Solution 3.1

A unchanged

B twice as large

C four times as large ✓

D half as large

Worked steps

C.

Exam-style 3.2 ▪ 1 mark

A 2.0 kg object accelerates at 5.0 m s^{-2}. The net force on it is

A 0.4 N

B 2.5 N

C 7.0 N

D 10 N

Solution 3.2

Method: Applying $F = ma$

A 0.4 N

B 2.5 N

C 7.0 N

D 10 N ✓

Worked steps

D — $F = 2.0 \times 5.0 = 10$ N.

Exam-style 3.3 ▪ 2 marks

Two blocks, 2.0 kg and 3.0 kg, sit in contact on a frictionless floor. A 15 N force pushes on the 2.0 kg block.
(a) Find the acceleration of the pair.
(b) Find the contact force between the blocks.

Solution 3.3

Method: Applying $F = ma$

Worked steps

(a) $a = \dfrac{15}{2.0 + 3.0} = 3.0$ m s^{-2} M1 A1. (b) On the 3.0 kg block, $F = ma = 3.0 \times 3.0 = 9.0$ N M1 A1.