

Exercise walk-through

2.5

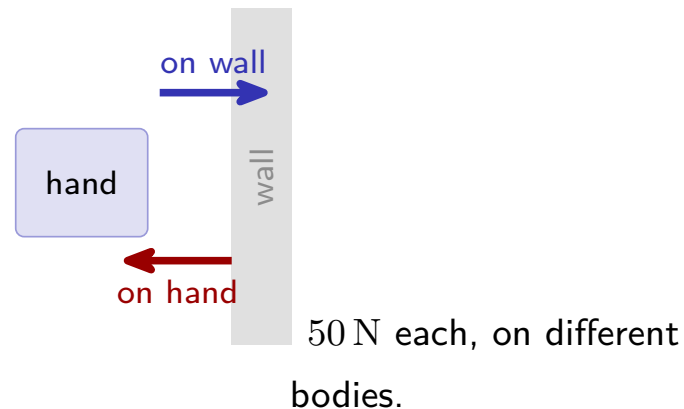
Newton's Second Law

AP Physics 1

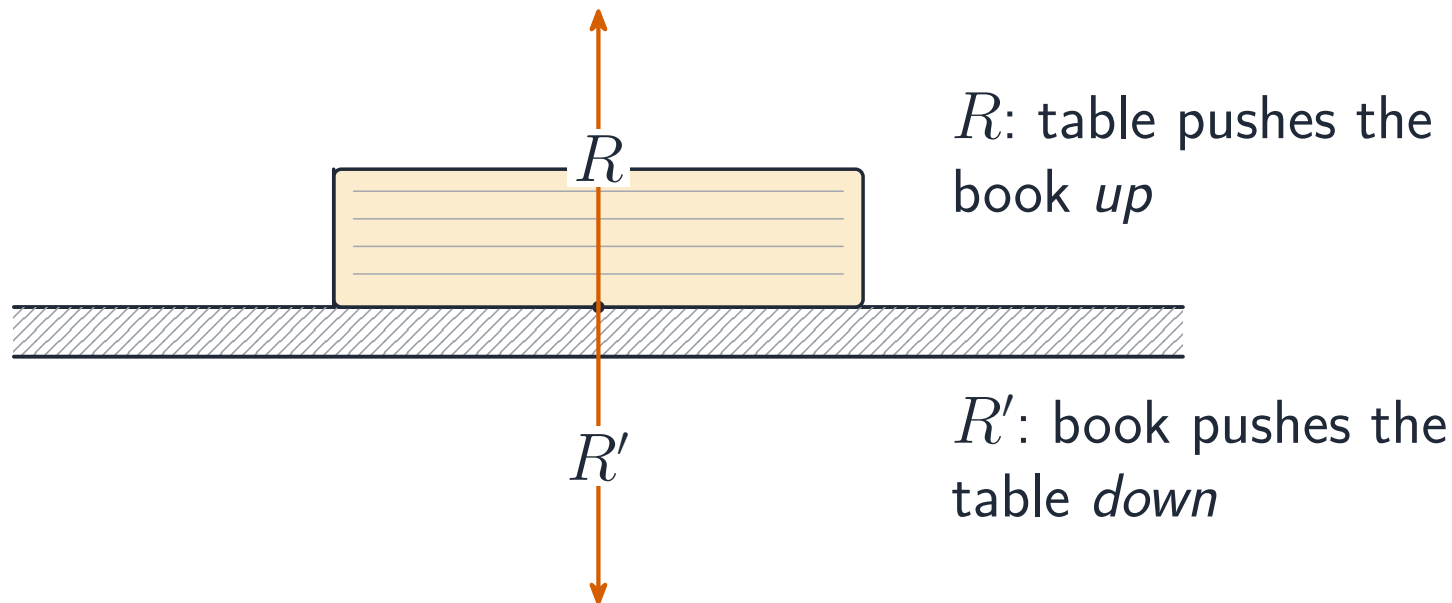
Newton's third law

Newton's third law : if A pushes B, then B pushes A back – **equal in size, opposite in direction**.

The two forces of a **force pair** act on **different objects**, so they can *never* cancel.



A Newton's third-law pair



A Newton's third-law pair: equal and opposite forces on two different objects

Newton's first law

Newton's first law : velocity stays constant unless a net force acts.

- **inertia** – resistance to a change in motion, measured by mass
- net force zero = **translational equilibrium**

“No net force” means **no change** in motion – not “no motion”.



Rockets accelerate by pushing exhaust out

Newton's second law

Newton's second law : a nonzero net force gives an acceleration.

The rule

$$\vec{a} = \frac{\sum \vec{F}}{m}$$

On a ramp, resolve forces into **perpendicular components** and apply it in each direction.

Worked example

20 N on a 5 kg box:

$$a = \frac{20}{5} = 4 \text{ m/s}^2$$

Double the mass $\Rightarrow$ the acceleration halves.

$a \propto F$, and $a \propto 1/m$.

Exercises 2.1-2.3

2.1 A net force of 20 N acts on a 4.0 kg trolley. Find its acceleration. [1]

2.2 A 1500 kg car accelerates at 2.0 m s^{-2} . Find the net force on it. [1]

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

Exercises 2.1·2.3

2.1 A net force of 20 N acts on a 4.0 kg trolley. Find its acceleration. [1]

2.1

- $a = \frac{20}{4.0} = 5.0 \text{ m s}^{-2}$

2.2 A 1500 kg car accelerates at 2.0 m s^{-2} . Find the net force on it. [1]

2.2

- $F = ma = 1500 \times 2.0 = 3000 \text{ N}$

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

2.3

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

Exercises 2.4·3.1

2.4 State how the acceleration changes if the net force doubles while the mass stays the same. [1]

3.1 If the net force on an object doubles and its mass halves, the acceleration becomes[1]

☐

A unchanged

B twice as large

C four times as large

D half as large

Exercises 2.4·3.1

2.4 State how the acceleration changes if the net force doubles while the mass stays the same. [1]

2.4

- it also doubles (acceleration is proportional to net force)

3.1 If the net force on an object doubles and its mass halves, the acceleration becomes[1]

☐

A unchanged

B twice as large

C four times as large

D half as large

3.1 C

- four times as large.

Exercise 3.2

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

[1]

☐

A 0.4 N

B 2.5 N

C 7.0 N

D 10 N

Exercise 3.2

3.2 A 2.0 kg object accelerates at 5.0 m s^{-2} . The net force on it is [1]

☐

A 0.4 N

B 2.5 N

C 7.0 N

D 10 N

3.2 D

- $F = 2.0 \times 5.0 = 10 \text{ N}$

Exercise 3.3 (a)

3.3 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.

[2]

Exercise 3.3 (a)

3.3 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.

[2]

(a)

- $$a = \frac{15}{2.0 + 3.0} = 3.0 \text{ m s}^{-2}$$

Exercise 3.3 (b)

3.3 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.

(b) Find the contact force between the blocks.

[2]

Exercise 3.3 (b)

3.3 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.

(b) Find the contact force between the blocks.

[2]

(b)

- On the 3.0 kg block, $F = ma = 3.0 \times 3.0 = 9.0 \text{ N}$