

Exercise walk-through

2.4

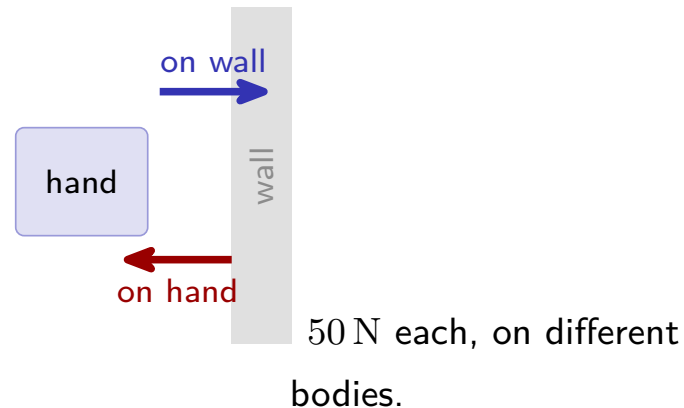
Newton's First Law

AP Physics 1

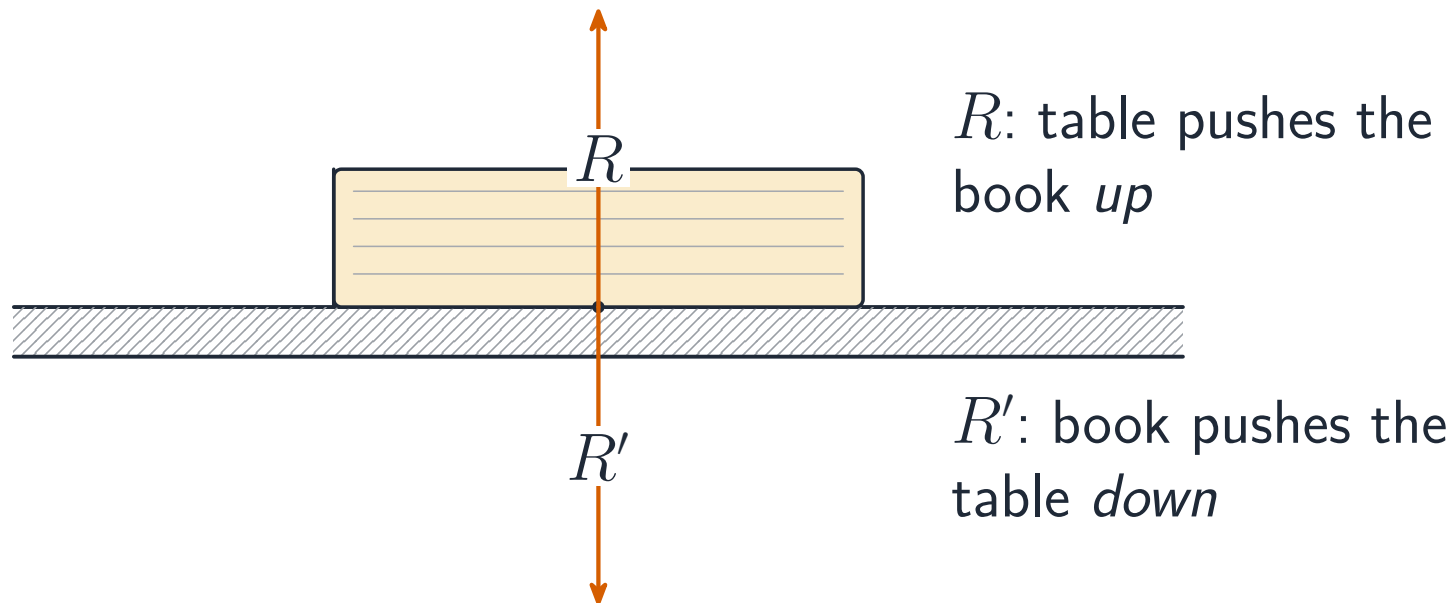
Newton's third law

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

2.2 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. [2]

2.3 Explain, using inertia, why passengers lurch forward when a bus brakes suddenly. [2]

Exercises 2.1-2.3

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

2.1

- zero – constant velocity means the forces are balanced
-

2.2 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. [2]

2.2

- friction = 7.0 N (it matches the push up to its maximum); the box does not move, since $7.0 < 12 \text{ N}$
-

2.3 Explain, using inertia, why passengers lurch forward when a bus brakes suddenly. [2]

2.3

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

Exercises 3.1-3.2

3.1 An object is in translational equilibrium. Its velocity must be

[1]

☐

A zero

B constant (possibly zero)

C increasing

D decreasing

☐

A a 0.5 kg ball

B a 2 kg book

C a 50 kg crate

D a 1 kg brick

3.2 Which object has the greatest inertia?

[1]

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3.1 B

- constant (possibly zero).

3.2 Which object has the greatest inertia?

[1]

☐

A a 0.5 kg ball

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3.2 C

- a 50 kg crate.

Exercise 3.3 (a)

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

(a) State the tension in the cable.

[1]

Exercise 3.3 (a)

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

(a) State the tension in the cable.

[1]

(a)

- 500 N

Exercise 3.3 (b)

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

(b) State the net force on the lamp, and justify with the first law.

[2]

Exercise 3.3 (b)

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

(b) State the net force on the lamp, and justify with the first law.

[2]

(b)

- zero – at rest is equilibrium, so the net force must be zero by the first law