

Exercise walk-through

# 1.2

## Momentum safety and moments (P)

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The method

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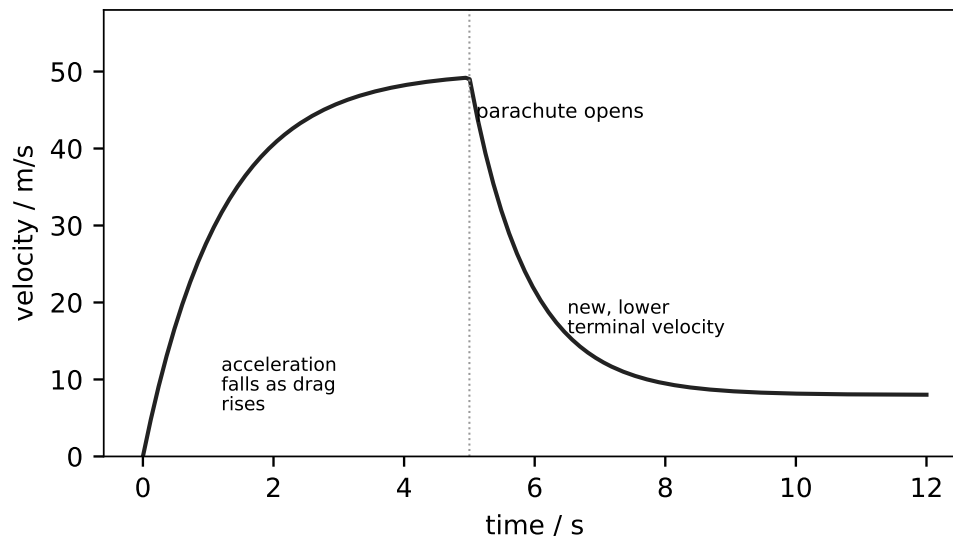
## Method — Momentum buys safety with time

$$p = m \times v \qquad F = \frac{\Delta p}{t}$$

Total momentum is conserved in collisions and explosions. Every safety feature – airbag, seat belt, crumple zone, crash mat, helmet – lengthens  $t$  so  $F$  falls.

## Method — Terminal velocity, stability and moments

$M = F \times d$  about the pivot; balance means clockwise = anticlockwise.



*Velocity against time for a parachutist with a second, lower terminal velocity.*

## Exercises 2.1·2.3

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**2.1 (P)** Calculate the momentum of a 0.4 kg ball at 15 m/s. [2]

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**2.2 (P)** State the conservation of momentum in a closed system. [1]

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**2.3** Name two factors that increase a driver's reaction time. [2]

## Exercises 2.1·2.3

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**2.1** (P) Calculate the momentum of a 0.4 kg ball at 15 m/s. [2]

**2.1** (P)  $p = 0.4 \times 15 = 6 \text{ kg m/s}$ .

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**2.2** (P) State the conservation of momentum in a closed system. [1]

**2.2** (P) Total momentum before an interaction equals total momentum after it.

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**2.3** Name two factors that increase a driver's reaction time. [2]

**2.3** Tiredness, distractions, drugs, alcohol (any two).

## Exercises 2.4·3.1

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**2.4 (P)** State two design features that reduce drag on a vehicle. [2]

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**2.5 (P)** Where does a symmetrical object's centre of mass lie? [1]

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**3.1 (P)** A 60 kg rider falls from a bike at 8 m/s and stops in 0.05 s without a helmet, or 0.20 s with one. Calculate the decelerating force in each case. [4]

## Exercises 2.4·3.1

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**2.4 (P)** State two design features that reduce drag on a vehicle. [2]

**2.4 (P)** Streamlined (teardrop) shape; smooth surfaces.

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**2.5 (P)** Where does a symmetrical object's centre of mass lie? [1]

**2.5 (P)** On its axis of symmetry.

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**3.1 (P)** A 60 kg rider falls from a bike at 8 m/s and stops in 0.05 s without a helmet, or 0.20 s with one. Calculate the decelerating force in each case. [4]

**3.1 (P)** Momentum change  $\Delta p = 60 \times 8 = 480 \text{ kg m/s}$ . Without:  $F = 480/0.05 = 9600 \text{ N}$ ; with helmet:  $F = 480/0.20 = 2400 \text{ N}$  – four times smaller.

## Exercises 3.2·3.3

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**3.2 (P)** A 4 kg trolley at 3 m/s collides with a stationary 2 kg trolley; they move off together. Calculate their common velocity. [3]

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**3.3 (P)** A see-saw balances with a 300 N child 1.6 m from the pivot. Calculate the distance of a 400 N child on the other side. [3]

## Exercises 3.2·3.3

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**3.2 (P)** A 4 kg trolley at 3 m/s collides with a stationary 2 kg trolley; they move off together. Calculate their common velocity. [3]

**3.2 (P)** Before:  $4 \times 3 = 12 \text{ kg m/s}$ ; after:  $(4 + 2)v = 12$ ;  $v = 2 \text{ m/s}$ .

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**3.3 (P)** A see-saw balances with a 300 N child 1.6 m from the pivot. Calculate the distance of a 400 N child on the other side. [3]

**3.3 (P)** Anticlockwise  $= 300 \times 1.6 = 480 \text{ N m}$ ; clockwise  $400 \times d = 480$ ;  $d = 1.2 \text{ m}$ .