

Exercise walk-through

4.1

Biomechanics: movement and impulse

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · H

4.1 Biomechanics: movement and impulse

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS base of support • impulse

Objective

Biomechanics: movement and impulse. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

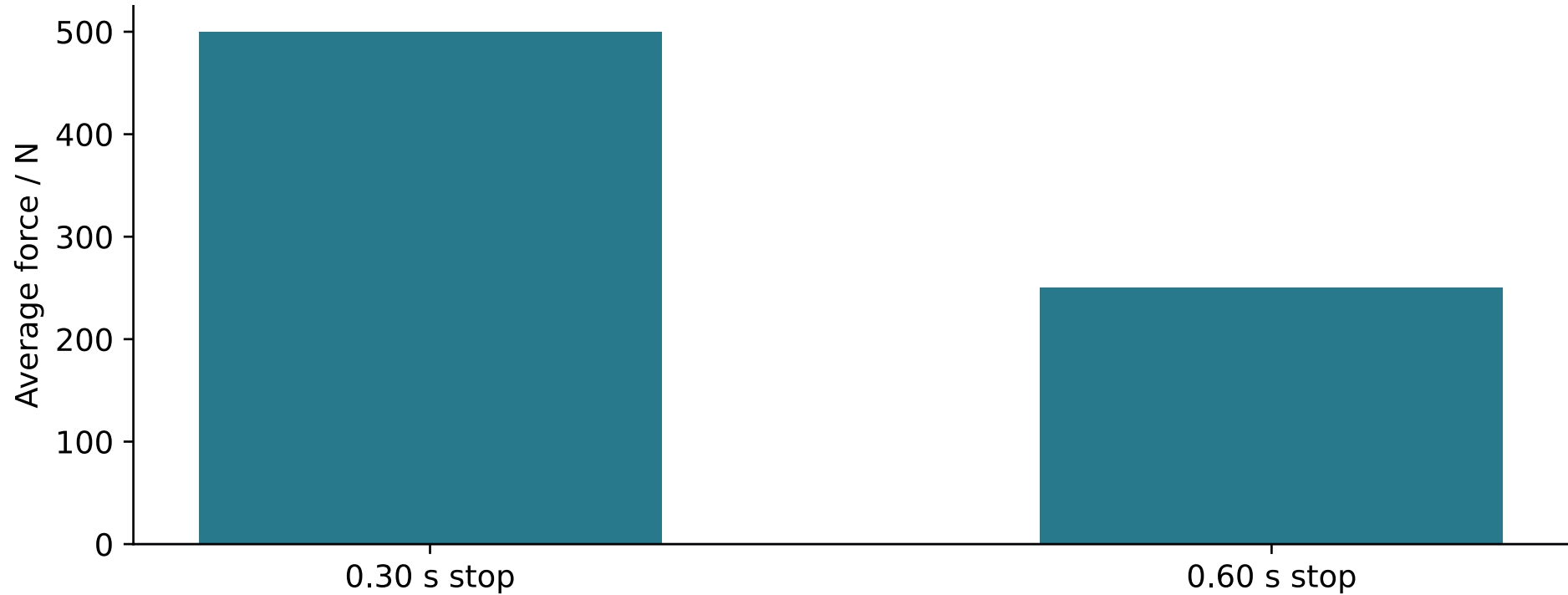
■ What would explain this observation?

- Landing with bent knees increases the time over which momentum changes. The movement can reduce average impact force for the same momentum change.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Joint movement results from muscle forces acting through lever systems. The centre of mass and **base of support** affect stability. **Impulse** connects force-time evidence to momentum change.

- impulse: Force integrated over time, equal to momentum change; base of support: The area supporting a body.



■ Choose evidence that can test it

- A biomechanical analysis must define the segment, direction and phase of movement. Net force and a single muscle force are not interchangeable. A longer lever arm can change torque without changing applied force.
- Use teacher-approved video of a safe movement with consent. Calibrate distance and time, identify frames consistently, and avoid making medical claims from a two-dimensional recording. Camera perspective can bias apparent joint angles.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions

fit this case, then rearrange before substitution.

- Known: momentum changes by 150 kg metres per second. Average force magnitude = momentum change/stopping time. For 0.30 s, force = $150/0.30 = 500$ N. For 0.60 s, force = $150/0.60 = 250$ N. This idealized average excludes the detail of a changing force curve.

Example:

Momentum change is 120 kg metres per second over 0.40 s. Find average force magnitude. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- The largest force is not the same as average force. A school movement study should not deliberately create high-impact landings to test a prediction.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A video from one angle proves the cause of a sports injury. This claim is false: The largest force is not the same as average force. A school movement study should not deliberately create high-impact landings to test a prediction.

Key:

Biomechanics: movement and impulse: A biomechanical analysis must define the segment, direction and phase of movement. Net force and a single muscle force are not

interchangeable. A longer lever arm can change torque without changing applied force.

Exercises 2.1-2.3

2.1 For a fixed momentum change, doubling stopping time does what to average force?
Choose one answer.

- **A** Halves it
- **B** Doubles it
- **C** Leaves it unchanged

[1]

2.2 Momentum change is 120 kg metres per second over 0.40 s. Find average force magnitude. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: A video from one angle proves the cause of a sports injury.

[2]

Exercises 2.1-2.3

2.1 For a fixed momentum change, doubling stopping time does what to average force? Choose one answer.

- **A** Halves it
- **B** Doubles it
- **C** Leaves it unchanged

[1]

2.1 A A biomechanical analysis must define the segment, direction and phase of movement. Net force and a single muscle force are not interchangeable. A longer lever arm can change torque without changing applied force.

2.2 Momentum change is 120 kg metres per second over 0.40 s. Find average force magnitude. Show the relation, substitution and units.

[2]

2.2 Average force magnitude=momentum change/time= $120/0.40=300$ N.

2.3 Decide whether this claim is true and justify: A video from one angle proves the cause of a sports injury.

[2]

2.3 False. The largest force is not the same as average force. A school movement study should not deliberately create high-impact landings to test a prediction.

Exercises 2.4·3.1

2.4 Force integrated over time, equal to momentum change: write the technical term. [1]

3 Exam-style questions

3.1 Fictional force curves deliver 120 N s impulse over 0.20 and 0.40 s. Compare average forces. Can peaks or injury risk be inferred? [4]

Exercises 2.4·3.1

2.4 Force integrated over time, equal to momentum change: write the technical term. [1]

3 Exam-style questions

2.4 impulse. impulse means Force integrated over time, equal to momentum change.

3.1 Fictional force curves deliver 120 N s impulse over 0.20 and 0.40 s. Compare average forces. Can peaks or injury risk be inferred? [4]

3.1 Averages are 600 and 300 N. Impulse specifies area, not force-curve shape or peak. Injury risk requires suitable evidence beyond this mechanical example; no individual recommendation follows.