

Exercise walk-through

1.1

Motion graphs and acceleration

International Baccalaureate · IB Diploma · Physics · HL

1.1 Motion graphs and acceleration

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

KEY WORDS velocity • acceleration

Objective

Motion graphs and acceleration. Original classroom practice for IB HL; not an official IB paper.

1 Key knowledge and worked examples

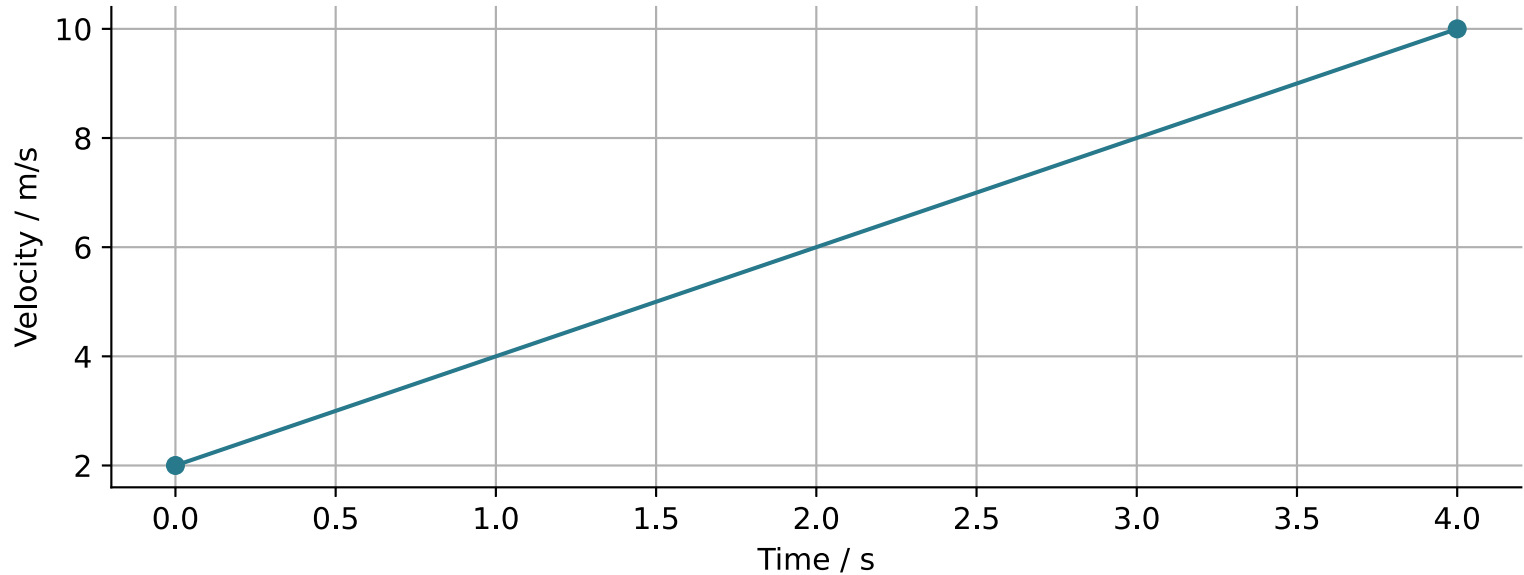
■ What would explain this observation?

- A speedometer gives a reading at one moment. A journey average can hide stops and rapid changes in speed.
-

■ Build the model

- Displacement includes direction; distance counts total path length.

- **Velocity** is change in displacement per time.
- **Acceleration** is change in velocity per time.
- velocity: Rate of change of displacement.
- acceleration: Rate of change of velocity.



■ Choose evidence that can test it

- The gradient of a displacement-time graph is velocity.
- The area under a velocity-time graph gives displacement.
- A constant-acceleration formula is valid only when its assumption is justified.

In the lab: Choose a positive direction and state it. Use a light gate or video with a known scale and frame interval for repeatable motion measurements. Avoid assuming hand timing is exact over very short intervals.

■ Work from known quantities

- Known: velocity rises uniformly from 2 to 10 metres per second in 4 s. $a = (v-u)/t$.
 $a = (10-2)/4 = 2$ metres per second squared.

- Displacement is trapezium area: $s = (u+v)t/2 = (2+10) \times 4/2 = 24 \text{ m}$.

Your turn: Velocity changes from 3 to 15 metres per second in 6 s. Find acceleration.

■ Check the conclusion and its limits

- Negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.

Not true: A negative velocity always means the object is slowing down. Negative velocity means motion opposite to the chosen positive direction. The object slows down only when the acceleration opposes the velocity; a negative velocity with negative acceleration is speeding up.

Key:

- Displacement includes direction; distance counts total path length.
- The gradient of a displacement-time graph is velocity.
- Watch for: negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.

■ Write from an acceleration of 6 metres per second squared

- Velocity changes from 4 to 22 metres per second in 3 s.
- Find the acceleration and the displacement. A negative velocity is a direction.

Exercises 2.1·2.3

2.1 What does area under a velocity-time graph represent? Choose one answer.

- **A** Displacement
- **B** Acceleration
- **C** Mass

[1]

2.2 Velocity changes from 3 to 15 metres per second in 6 s. Find acceleration. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: A negative velocity always means the object is slowing down.

[2]

Exercises 2.1-2.3

2.1 What does area under a velocity-time graph represent? Choose one answer.

- **A** Displacement
- **B** Acceleration
- **C** Mass

[1]

2.1 A Area under a velocity-time graph has units of velocity x time = metres, which is displacement. Acceleration is the GRADIENT of the same graph, and mass does not appear on it at all.

2.2 Velocity changes from 3 to 15 metres per second in 6 s. Find acceleration. Show the relation, substitution and units.

[2]

2.2 $a = (v - u) / t = (15 - 3) / 6 = 2 \text{ m/s}^2$.

2.3 Decide whether this claim is true and justify: A negative velocity always means the object is slowing down.

[2]

2.3 False. Negative velocity means motion opposite to the chosen positive direction. The object slows down only when the acceleration opposes the velocity; a negative velocity with negative acceleration is speeding up.

Exercises 2.4·3.1

2.4 Rate of change of displacement: write the technical term.

[1]

3.1 Velocity falls uniformly from $+6$ to -2 m/s in 4 s. Find acceleration, displacement and distance. Explain why the last two differ.

[4]

Exercises 2.4·3.1

2.4 Rate of change of displacement: write the technical term. [1]

2.4 velocity. velocity means Rate of change of displacement.

3.1 Velocity falls uniformly from $+6$ to -2 m/s in 4 s. Find acceleration, displacement and distance. Explain why the last two differ. [4]

3.1 $a = -2$ m/s²; displacement $= (6 - 2) \times 4 / 2 = 8$ m. Velocity crosses zero at 3 s; triangle areas give distance $9 + 1 = 10$ m. Distance adds path lengths despite reversal.