

1.1 Motion graphs and acceleration

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS velocity • acceleration

Objective

Motion graphs and acceleration. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

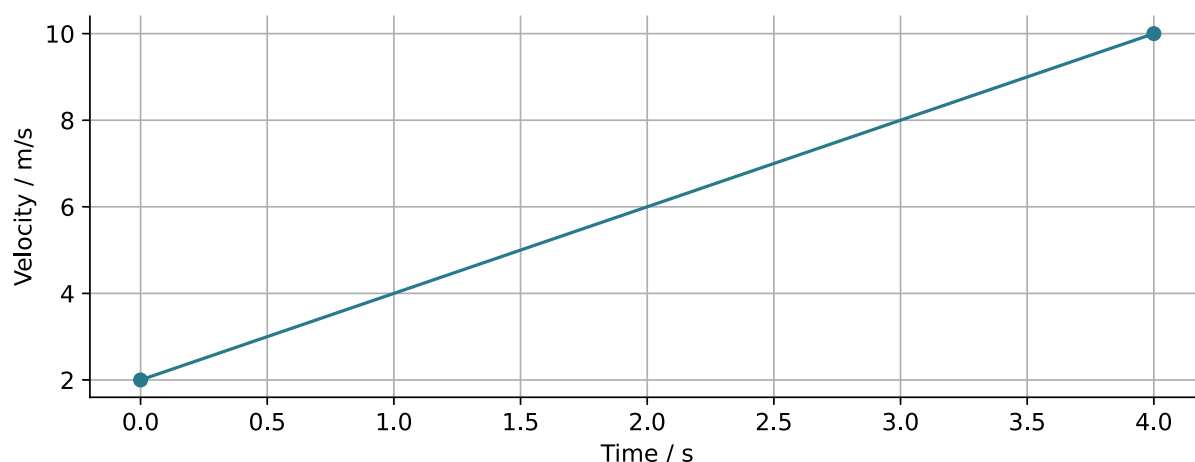
1 Key knowledge and worked examples

■ What would explain this observation?

- A speedometer gives a reading at one moment. A journey average can hide stops and rapid changes in speed.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ 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.
 - 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.
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■ 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: 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: $s = (u+v)t/2 = (2+10) \times 4/2 = 24$ m.

Example:

Velocity changes from 3 to 15 metres per second in 6 s. Find acceleration. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- Negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A negative velocity always means the object is slowing down. This claim is false: Negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.

Key:

Motion graphs and acceleration: 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.

2 Practice

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]

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

3 Exam-style questions

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]

Solutions

2.1 A 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.

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

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

2.4 velocity. velocity means Rate of change of displacement.

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