

Exercise walk-through

1.3

Representing Motion

AP Physics C: Mechanics

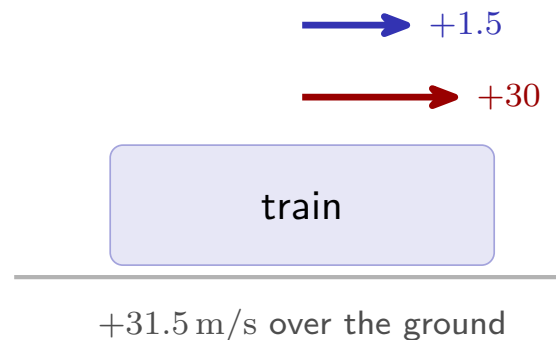
Reference frames and relative motion

Velocities add as vectors between frames:

Frame conversion

$$\vec{v}_{A/C} = \vec{v}_{A/B} + \vec{v}_{B/C}$$

Frames moving at **constant** relative velocity share the same acceleration – they are **inertial**, and Newton's laws hold identically.



Relative motion is vector addition

the rule

$$\vec{v}_{A/C} = \vec{v}_{A/B} + \vec{v}_{B/C} - \text{the inner subscripts cancel}$$

reversing

$$\vec{v}_{B/A} = -\vec{v}_{A/B}$$

a boat crossing

add the boat's velocity through the water to the water's velocity over the ground

**reference
frame**

all motion is measured relative to one; there is no absolute rest

Write the subscripts before the numbers. If the inner pair does not cancel, you have chained the frames the wrong way round.

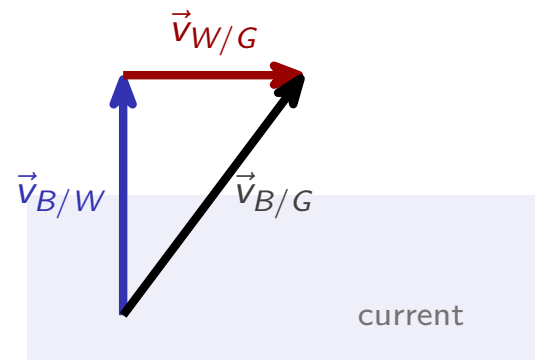
A boat crossing a river

The boat's ground velocity is the **vector sum** of its velocity through the water and the current:

$$\vec{v}_{B/G} = \vec{v}_{B/W} + \vec{v}_{W/G}$$

Across 3.0, downstream 2.0

$$|\vec{v}_{B/G}| = \sqrt{3.0^2 + 2.0^2} \approx 3.6 \text{ m/s}$$



Exercises 2.1-2.3

2.1 What does the slope of a position-time graph represent? [1]

2.2 What does the area under a velocity-time graph represent? [1]

2.3 A v - t graph holds a constant 6 m s^{-1} for 5 s. Find the displacement. [2]

Exercises 2.1-2.3

2.1 What does the slope of a position-time graph represent? [1]

2.1

- The velocity
-

2.2 What does the area under a velocity-time graph represent? [1]

2.2

- The displacement
-

2.3 A v - t graph holds a constant 6 m s^{-1} for 5 s. Find the displacement. [2]

2.3

- Displacement = area = $6 \times 5 = 30 \text{ m}$

Exercises 2.4·3.1

2.4 A v - t graph rises straight from 0 to 8 m s^{-1} over 2 s. Find the acceleration. [2]

3.1 The acceleration of an object equals the slope of its [1]

☐

A position-time graph

B velocity-time graph

C acceleration-time graph

D force-time graph

Exercises 2.4·3.1

2.4 A v - t graph rises straight from 0 to 8 m s^{-1} over 2 s. Find the acceleration. [2]

2.4

- $a = \frac{\Delta v}{\Delta t} = \frac{8}{2} = 4 \text{ m s}^{-2}$

3.1 The acceleration of an object equals the slope of its [1]

☐

A position-time graph

B velocity-time graph

C acceleration-time graph

D force-time graph

3.1 B

- acceleration is the slope of the velocity-time graph

Exercise 3.2

3.2 For motion with constant acceleration, the velocity-time graph is a

[1]

☐

A horizontal line

B straight sloped line

C parabola

D circle

Exercise 3.2

3.2 For motion with constant acceleration, the velocity-time graph is a

[1]

☐

A horizontal line

B straight sloped line

C parabola

D circle

3.2 B

- constant acceleration gives a straight sloped v - t line

Exercise 3.3 (a)

3.3 A v - t graph is a triangle: velocity rises straight from 0 to 12 m s^{-1} over 6 s.

(a) Find the acceleration.

[2]

Exercise 3.3 (a)

3.3 A v - t graph is a triangle: velocity rises straight from 0 to 12 m s^{-1} over 6 s.

(a) Find the acceleration.

[2]

(a)

- $a = 12/6 = 2 \text{ m s}^{-2}$

Exercise 3.3 (b)

3.3 A v - t graph is a triangle: velocity rises straight from 0 to 12 m s^{-1} over 6 s.

(b) Find the displacement (the area).

[2]

Exercise 3.3 (b)

3.3 A v - t graph is a triangle: velocity rises straight from 0 to 12 m s^{-1} over 6 s.

(b) Find the displacement (the area).

[2]

(b)

- $\text{area} = \frac{1}{2}(6)(12) = 36 \text{ m}$

Exercise 3.4 (a)

3.4 An x - t graph is a horizontal straight line for 10 s.

(a) State the velocity.

[1]

Exercise 3.4 (a)

3.4 An $x-t$ graph is a horizontal straight line for 10 s.

(a) State the velocity.

[1]

(a)

- $v = 0$ (the position is constant)

Exercise 3.4 (b)

3.4 An x - t graph is a horizontal straight line for 10 s.

(b) State the acceleration.

[1]

Exercise 3.4 (b)

3.4 An x - t graph is a horizontal straight line for 10 s.

(b) State the acceleration.

[1]

(b)

- $a = 0$