

Solutions

Each answer shows the steps, then the **result**.

2.1

- both velocities point forward, so they add:

$$v_{PG} = v_{PB} + v_{BG} = 1.5 \text{ m s}^{-1} + 12 \text{ m s}^{-1}$$

- $v_{PG} = \mathbf{13.5 \text{ m s}^{-1}}$ forward

2.2

- relative velocity is the difference of the ground velocities:

$$v_{AB} = v_A - v_B = (+25 \text{ m s}^{-1}) - (+18 \text{ m s}^{-1})$$

- $v_{AB} = +\mathbf{7 \text{ m s}^{-1}}$ (A pulls ahead of B)

2.3

- take one car's direction as positive, so the other is -20 m s^{-1} :

$$v_{12} = v_1 - v_2 = (+20 \text{ m s}^{-1}) - (-20 \text{ m s}^{-1})$$

- relative speed = $\mathbf{40 \text{ m s}^{-1}}$

2.4

- the heading and the current are perpendicular, so use Pythagoras:

$$v = \sqrt{v_{\text{boat}}^2 + v_{\text{current}}^2} = \sqrt{(6 \text{ m s}^{-1})^2 + (8 \text{ m s}^{-1})^2}$$

- $v = \mathbf{10 \text{ m s}^{-1}}$

3.1 B

- velocity is defined relative to a reference frame

3.2 B

- same direction, so subtract:

$$v_{\text{rel}} = v_1 - v_2 = 30 \text{ m s}^{-1} - 22 \text{ m s}^{-1} = 8 \text{ m s}^{-1}$$

3.3

(a)

- the heading and the current are perpendicular, so use Pythagoras:

$$v = \sqrt{v_{\text{swim}}^2 + v_{\text{current}}^2} = \sqrt{(2 \text{ m s}^{-1})^2 + (1.5 \text{ m s}^{-1})^2}$$

- $v = \mathbf{2.5 \text{ m s}^{-1}}$

(b)

- The current carries the swimmer downstream while crossing

3.4

(a)

- Straight down

(b)

- A parabola – it keeps the train's forward velocity